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A Record of the Progress of Pharmacy and the Allied Sciences

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CONTENTS

Editorial:

"Aberglaube und Hexerei" 715

Original Articles:

The Heart. (With Illustrations.) By Arno Viehoever, Philadelphia, Pa. 718

The Wellcome Historical Medical Museum and Its Founder, Henry S. Wellcome. (With Illustrations.) By Joseph W. England, Philadelphia, Pa. 745

Translated Article:

Microchemical Characterization of Drugs. (With Illustrations.) By L. Rosenthaler, Berne, Switzerland 757

Abstracted and Reprinted Articles:

Industrial Changes Due to Chemistry. By Edward R. Weidlein. (Reprinted from *The Annals of the American Academy of Political and Social Science*, Philadelphia, Pa.) 765

Millilitre or Cubic Centimetre? by W. H. Linnell. (Reprinted from *Pharmaceutical Journal*, London, England) 792

Medical and Pharmaceutical Notes

794

Book Reviews

797

Index

799

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THE AMERICAN JOURNAL OF PHARMACY

VOL. 100

DECEMBER, 1928

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EDITORIAL

ABERGLAUBE UND HEXEREI

A RECENT WRITER, after contrasting the past with the present in the matters of progress both material and intellectual, ventured the statement that "mankind is on the verge of mental maturity."

Mental mush! It is true that the present is an age of literary and of technical skill, comparatively speaking, but so far as mental development is concerned it is quite probable that the average of human credulity is not much changed since the days of the "Royal Touch." It is true that clairvoyants, crystal gazers and fortune tellers have a somewhat shame-faced and clandestine clientele and that those who carry a rabbit's foot for luck or a horsechestnut or a potato for rheumatism, rarely advertise the fact or expose these treasures to public view, so that accurate statistics are not obtainable, and one person's estimate is as good as another's.

Several years ago the writer of this editorial prepared and delivered a lecture entitled "The Romance of the Occult." The reverberations of this lecture have not yet died away and letters are still occasionally received asking the cost and duration of the courses on various phases of occultism and magic, and catalogues still arrive from publishers of books on occultism and from those who offer to supply all kinds of apparatus and accessories, ranging from crystal balls down through kabbalistic talismans on genuine parchment to authentic oriental incense powder, guaranteed to evoke spirits.

"Judge nothing lightly; think twice before you condemn the teachings of those who have entered the sanctuary and passed through a certain antique secret initiation. For a second time have the fruits of the tree of knowledge of good and evil been gathered and shared,

so that those who are sincere may yet become masters of the secrets of the occult world."

The foregoing quotation is from one of the latest of these catalogues. Is this an indication that we are nearing mental maturity? Look at the advertising on the religious page of a Los Angeles Sunday newspaper. Mental maturity? Mental misjudgment!!

Go up through the beautiful farming districts of Berks and Lehigh Counties in Pennsylvania, look carefully at the gable ends and sides of the barns. There you will frequently see mystic pentagrams and reproductions of the seal of Solomon painted thereon to keep the evil spirits away from the cattle. Is mental maturity nearing its zenith here? Of course, it may be that in some cases the original meaning of these signs has disappeared and that they are continued merely as a custom that has been handed down, but in view of some of the recent happenings in these regions, it is not too much to say that the belief in the signs is still active.

Look at the court proceedings of some of these counties of southeastern Pennsylvania. Here you will find records of charges and countercharges regarding such practices as "powwowing" of frequent occurrence, and the latest development in this connection is a murder committed at the instigation of one of these practitioners in order to get a lock of the victim's hair to use in some clandestine and occult rite. If this be mental maturity, then our madhouses are populated by the intelligentsia.

Go to certain bookstores in any large city and you will be able to purchase books printed today, not as literary curiosities but for actual use by "Cro-magnons" of the twentieth century, on "Egyptian Secrets," "Forbidden Knowledge," "Mysteries of the Ancient Philosophers," "The Sixth and Seventh Books of Moses," "The Black Arts (including magic, witchcraft, alchemy and necromancy)," and "Pow-wows." Let us quote a paragraph or two from several of these works:

"When a horse is stubborn while being shod: Speak into his ear 'Caspar raise thee, Melchior bind, and Balthasar entangle thee'."

"How to discover whether cows are troubled by witches: In such a case the hair bristles up against the head, and they sweat much by night or toward morning."

"If you want to cite and compel spirits to appear visibly before you and render you obedience, then observe the following instructions:" Here follow about ten pages of detailed in-

structions involving the use of a great circle, in which the operator stands, parchment inscribed with the mysterious symbols written with the blood of young white doves; others written with the blood of butterflies, etc. Then:

"Since the spirits will now appear quickly, bring your desires forward honestly . . . for all this power and word of might which Moses, Aaron and Solomon used according to the revelations of God, are sufficient to compel the spirits to reveal to you the treasures of the earth and sea, and to give them to you without harm and deception."

The spirits are Aziel, Ariel, Marbuel, Mephistopheles, Barbuel, Azabiel and Anituel. Mental maturity? Mental misapplication!!

But let us not insult the Cro-magnon, even though the users and believers in these books are familiar with automobiles, electricity and radio.

Perhaps you may think that such books are printed and "bootlegged" secretly by publishers of no standing and that our modern newspapers are constructively assisting in an effort to rid the world of such superstitious practices? Not so. In many of our large metropolitan dailies you will find an astrological advisor's column, called "Today in Astrology." Shades of John Dee and Tycho Brahe! Are we nearing intellectual maturity? If we are, then who purchased the fifty-five millions of bottles of a single nationally advertised nostrum during the past decade.

"Take your foot off the rung of my chair and don't offer me a two-dollar bill!"

Mental maturity? Mental microscopcity! Or mental mendacity!

CHARLES H. LAWALL.

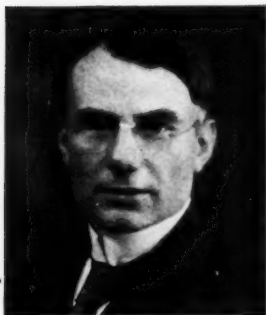
ORIGINAL ARTICLES

THE HEART*

By Dr. Arno Viehoever

Director of the Biological and Microanalytical Laboratories, and
College Experimental GardensThe Liver is the Seat of Love, The Heart the Organ of
Courage.—Galen

A HEART-TO-HEART TALK: The subject far too ambitious for one evening's lecture, was nevertheless chosen for various good reasons. One of them was my desire, after years of study of *Digitalis*, the Heart Stimulant par excellence, to gather data on the heart itself.



Dr. Arno Viehoever

Through the courtesy of various agencies I have been favored with films,¹ which, I trust, show in a satisfactory manner the animal and especially the human heart at work. Even a brief general discussion should give us all an excellent opportunity to realize the progress that medical art has made in the understanding of the noblest part in man's make-up—the heart. The fact that the heart, the provider of blood

circulation, is the center of *life and strength*—now known to many, must become known to all. The beating heart is indeed romantically considered the receiving and sending station of our deep and great emotions. In consequence we find abundant references, such as, The Heart of the Nation (Washington), the heart of this or that city, this or that mountain range. No love story is possible without reference to the heart; we find its daily mention in the public press, on posters and cards. Just remember the pang on Valentine's Day and the hearts that are lost or given away within a few hours. Then there is the "broken heart"—often more costly than painful, the buried heart—the evidence of a once living glory, and the really sick heart,

*One of a Series of Popular Science Lectures delivered at the Philadelphia College of Pharmacy and Science, 1927-1928 Season.

¹ These films were demonstrated at the Popular Lecture.

more common among us humans than generally known, in the very forefront of human afflictions.

Great credit is due the associations which have given special attention to Heart Diseases, their causes, their cure and protection. I mention especially the American Heart Association in New York, and affiliated organizations such as the Regional Heart Association of New England, the State Heart Associations of Iowa and Pennsylvania, the local Heart Associations of Chicago and Harrisburg, Philadelphia, San Antonio, St. Louis and the Heart Committees of six State, County and Local Medical Associations and of seven health organizations, all disseminating useful information and urging care



Fig. 1

Courtesy Survey Graphic.

Hearts Are Pumps. Drawn by Hendrik Van Loon.

and caution. More general support must be given these activities to benefit the young, the old, the individual family and communities. Many clinics have been established for the exclusive treatment of heart disease, but research into the nature and cure must be further fostered before man is master of his heart.

I

Strong Hearts

THE ENGINE

The heart, a living pump, a mechanism controlled by nerves, forces the blood through the human body in unceasing circulation away from it and back again. Its action is similar to the efficient water systems of our cities, more complicated, more wonderful, with blood vessels instead of water mains, with blood instead of water.

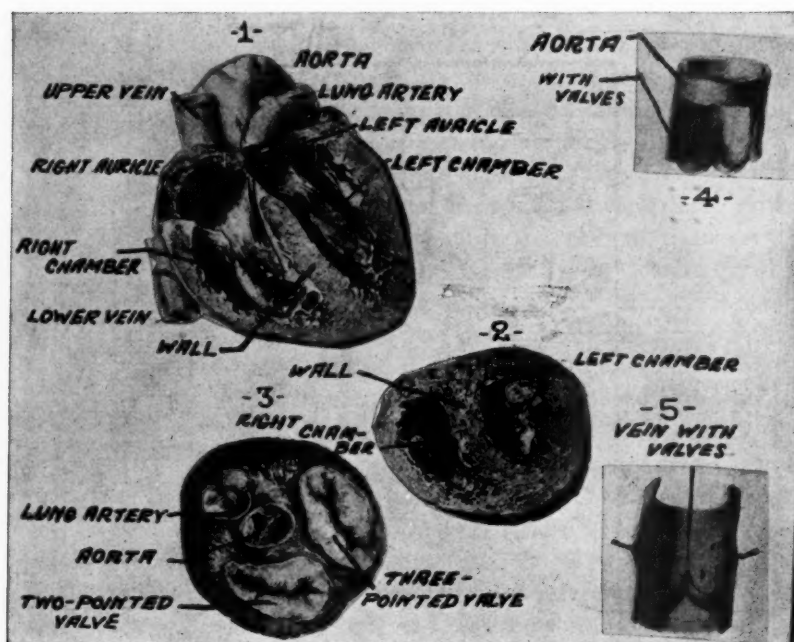


Fig. 2

1. Heart, Opened From the Front. 2. Heart in Cross-section. 3. Heart Contracted, Auricles Removed. Valve Closed. 4. Valves of the Aorta. 5. Valves of the Vein. (After Brockhaus.)

The heart weighs about eight or nine ounces in the normal adult. Sometimes enlarged, due to causes such as over indulgence, this so-called "ox-heart" may weigh thirty and even fifty ounces.

The heart is located in the left chest, and partly enfolded by the lungs. The human heart, like that of other mammals, is divided

by a muscular wall into two completely separate parts, a right and a left, with two chambers each, acting as pumps. The upper chambers, "atria" or "auricles," are connected with the lower chambers, "ventricles," by valves. The inner structure of the organ is indeed intricate, like the mechanism of a watch, though a still greater marvel. The valves, acting much like valves in springs, prevent the flow of blood in the wrong direction, in particular, the back flow. A delicate membrane, "the endocardium," lines the interior of the heart.



Fig. 3

Completely Contracted Human Heart in Cross-Section Near Lower Third. (After Krehl.)

The heart, placed into the rigid heartsac pericardium, forms together with it a membrane—suction—and pressure pump. This is Hauffe's view, supported by Ohm's Roentgen ray observations. The sac corresponds to the wall of the pump, the successively contracting auricles and ventricles represent the moving pistons; the contraction of the auricle produces a reduction of space in the heart sac, causing a suction of the blood into the ventricle and from there into the arteries.

The heart engine starts running long before actual birth; it beats, pressing periodically against the chest wall, about 150 times in the

embryo and on an average of 70-80 times per minute in the adult; it is always at work, its hollow muscle contracting, losing its blood in the systole, and expanding, relaxing and filling itself again in the diastole, independent of our mind and will; hastened and retarded by a multitude of influences; running on without stop, the whole of a lifetime; a most efficient muscular machine that can be repaired only while it is functioning, and that beats on, despite strain or pain, leaking valves and palpitation, until only death ends its ceaseless efforts.

**PROPERTIES OF
HEART MUSCLE**

The heart muscle only reacts if the stimulus is great enough to cause a single maximum contraction, followed by relaxation. A somewhat similar effect may be observed in water dropping from a slowly running spigot only when the weight of the drop exceeds the resistance of the tension existing at the surface. After the heart contraction begins, stimulation has no immediate effect. Due to these characteristics, the heart may beat rhythmically even though it is highly stimulated. Always a hastened rhythmic, rather than a lasting contraction, takes place.

**SELF ACTION
(AUTOMATY)
OF THE HEART**

A heart may continue to beat, if it is removed from the organism; it must contain, therefore, the cause for the rhythmic beat in itself. Certain parts resembling embryonic muscles respond more readily, spontaneously, to stimulation of the rhythm. In the right upper chamber, at the mouth of the large veins, this tissue, the "sinus node"—the center of rhythmic action, the "pace maker" is found. Another spontaneously reacting node is found between the upper and the lower main chamber. These nodes, connected with a fine set of specific muscle fibers, evidently represent the system that conducts and distributes the stimulation upon the single contractile heart element.

The ramification of the conducting system, according to the cytologist Dr. Wingate Todd, extends throughout the heart substance from the entry of the great veins to the terminal expansions in the ventricular walls, passing through the junction of upper and lower chambers in diverse manner by several alternate paths.

The control of the automatic action is exceedingly complicated. Salts of the blood plasma play an important rôle, the effect of one being harmful—if another is absent. An excess of potassium ions may stop the heart, if the excess cannot be compensated by calcium ions. Automaty may be produced by stimulation of the sinus, the

leading tissue in the upper chamber, by the local application (with filter papers, for instance) of potash solutions. These solutions, when applied to the whole heart, stop its beat.

The explanation of the automaty of the heart may actually be found in the fact that certain substances—hormones—discussed later, are formed in the automatic centers.

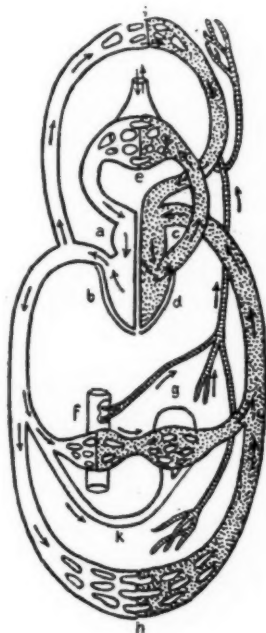


Fig. 4

Blood Circulation—Left Side a: Upper Chamber (Auricle); b: Lower Chamber (Ventricle); Right Side c: Upper Chamber (Auricle); d: Lower Chamber (Ventricle); e: Lung Circulation; f: g: h: Capillaries of Intestines, of Liver, of Lower Extremities; i: Capillaries of Head and Upper Extremities; k: Artery of Liver. (After Tigerstedt.)

CIRCULATION

The blood, in its continuous travel through all parts of the body, provides, among other things, the all-important oxygen. This element, abundant in the atmosphere, more abundant in the water, a mixture of hydrogen and oxygen, provides for oxidation and thus maintains and sustains the complicated dynamic molecular organization which we call life.

The vessels, which conduct the oxygenated (oxygen-laden) blood from the heart to all parts of the body, are the arteries. The blood flow is intermittent and is regulated by the rhythmical beating of the heart (the flow in the veins is continuous).

The walls of the arteries have to resist a considerable pressure. They must be stronger and more elastic than those of the veins with thinner walls, and a limited number of smooth muscles. Valves are present to prevent the back flow of the blood.

Besides the arteries and veins, numerous capillaries function in the transportation of blood, carrying it among themselves and in the various tissues of the respiratory, digestive and glandular system.

The heart muscle has a private blood supply—the coronary arteries or coronaries, serving the proper nourishment of the heart.

As the muscular wall between the heart partitions is impenetrable, the blood can only reach the left from the right side through the lungs, thus forming the small circulatory system. Through numerous blue veins the blood reaches the right upper chamber. From here the lung artery carries it to the lungs, where it exchanges oxygen for the carbon dioxide excreted from the lungs. From the left chamber the blood runs in the main blood-channel "aorta," which distributes it through many arterial branches to all parts of the body. It is saturated with oxygen and carries this in its progress throughout the closed tube (vascular) system—together with the food elements made available in the digestive system. It collects those decomposition products that are not otherwise taken care of, *i. e.*, excretion through the kidneys and skin, and returns through countless veins to the upper heart chamber, thus forming the large circulatory system, first recognized by Dr. Harvey, exactly 300 years ago.

Harvey described his experiment as follows: Let an arm be tied up above the elbow as if for blood-letting (phlebotomy) (A, A, Fig. 1). At intervals in the course of the veins, especially in laboring people and those whose veins are large, certain knots or elevations (B, C, D, E, F) will be perceived and this not only at the places where a branch is received (E, F) but also where none enters (C, D): these knots or risings are all formed by valves, which thus show themselves externally. . . . Apply the thumb or finger over a vein in the situation of one of the valves in such a way as to compress, and prevent any blood from passing upwards from the hand; then, with a finger of the other, streak the blood in the vein upwards till it has passed the next valve above, the vessel now remains empty;

the finger being removed for an instant, the vein is immediately filled from below; apply the finger again and having in the same manner streaked the blood upwards, again remove the finger below, and again the vessel becomes distended as before; and this repeat, say a thousand times, in a short space of time. And now compute the quantity of blood which you have thus pressed up beyond the valve, and then multiplying the assumed quantity by one thousand, and you will find that so much blood has passed through a certain portion of the vessel; and I do now believe that you will find yourself convinced of the circulation of the blood and its rapid movement.

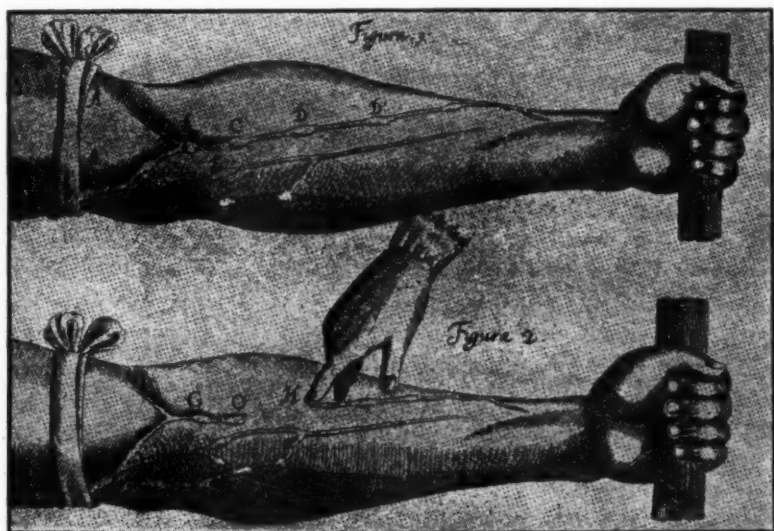


Fig. 5

Harvey's Own Illustration of One of His Experiments With Circulation.

Dr. Hill, the London authority on muscular movement in man, calculated the amount of blood-circulation and oxygen needed at rest and in action. He concludes that in man of ordinary size (about 150 pounds) the blood circulates through the body about once a minute and carries 4 per cent. (250 ccm.) of the available oxygen in four to five liters of blood. In a man hard at work (*e. g.*, rowing) the amount circulated per minute is enormously increased. The oxygen intake is 4.4 liters per minute, requiring thirty-four liters of blood to

carry it. As only about five liters of blood are available in the whole body, the blood must circulate about seven times every minute. Inasmuch as these thirty-four liters go through the right and once through the left side, sixty-eight liters of blood pass the heart per minute, an enormous output for a pump weighing only about one pound. During such activity the heart consumes as much oxygen as the whole body at rest.

HEART NERVES

The heart, as all other autonomously innervated organs, has two nerve systems, balanced but antagonistic. When one, vagus, is stimulated, the other, sympathicus, is depressed. The right function of vital processes and the involuntary muscle depends upon the even balance of the two nerve parts.

They work, says Dr. Ellice McDonald, the able Philadelphia physician and investigator, in different ways, the vagus division stimulates the stomach and intestines and slows and weakens (inhibits) the heart, while the sympathetic division increases the heart's action (stimulates) and slows up the stomach and intestines. It is as if the black gang on the ship were in two shifts and has care of two engines. The starboard watch of the black gang (the vagus division) makes the cook's galley and the commissariat (the gastrointestinal tract) work hard, but cuts down steam on the turbines (the heart) and the port watch (the sympathetic division) keeps up steam on the turbines, but cuts down on the cook's galley. But both are necessary to proper running, and if one works more than another, it will go hard with the ship. The proper balance or equilibrium of both sides of the vegetative nervous system is then necessary to the proper balance of the human craft.

Nerve action is associated with chemical conditions of the body and indeed influenced by them. When the liquid around the heart is acid, the heart beats slower (vagus action), when the liquid is alkaline, the heart beats faster (sympathetic action).

BLOOD PRESSURE

Blood pressure means the pressure of the blood against the arterial walls—it is comparable to the air pressure in automobile tires, or the water pressure in a rubber sprinkling hose. The amount of blood pressure, if too low or too high, is readily and painlessly determined in a few minutes by Harvey's method, *i. e.*, by shutting off the pulse in the large artery of the arm.

Normal blood pressure depends on the proper balance of these three factors: the beat of the heart, the elasticity of the arteries, and the resistance to the flow of blood exerted by the smaller blood vessels or capillaries.

Age, sex, and general conditions under which it is taken, influence the blood pressure. It varies during physical exercise, or moments of great emotion.

The normal blood pressure in a man of forty corresponds to about a 130 mm. mercury column, being somewhat lower in a woman, and rises about 4 mm. for every ten years.

It takes about thirty-four seconds, according to Prof. E. K. Marshall's findings, until an appreciable amount of blood, leaving the lungs through the left heart, returns again to the right heart; this finding agrees with Hill's statement of amount of blood circulation at rest.

The capillaries of the circulatory system have smooth muscles. Most of the interchange of substances with the blood takes place in these capillaries. Their total length has been estimated at 62,000 miles—a distance equal to two and one-half times the circumference of the world.

The influence of the vegetative nervous system in contracting and filling these capillaries, and its effect upon the nutritional process (metabolism) is indeed great.

The heart, according to Dr. McDonald, pumps normally seven and one-half tons of blood a day—energy sufficient to lift one ton 120 feet high. Under great stress the heart beats faster and harder, the work and the blood pressure being much increased.

Composition

GLYCOGEN The heart muscle, like other muscles, contains as one of its important constituents, glycogen—a carbohydrate. During work this is converted into lactic acid, which disappears again, under the influence of oxygen. The amount and rate of lactic acid production depends on the magnitude and intensity of the effort. The removal is complete in recovery. Dr. Hill suggests that lactic acid might be regarded as a governor of oxidation in the body; the higher its concentration the more rapid the oxidation—the glycogen reappearing possibly as a result of the reaction; lactic acid—hexose, the sugar being then polymerised as glycogen.

SALTS

Calcium is needed as the greatest source for the blood supply of alkaline salts. The blood is predominately alkaline, *i. e.*, if this balance is lost and the blood becomes overcharged with acids, health may be so seriously impaired that death may ensue.

The oxygen combines with the red blood pigment, hemoglobin, and is carried as oxy-hemoglobin to the very part where it is needed. It is not stored, as fat is stored in the body, but is carried through the tissues to the last cell of the body, where the oxygen is used to generate the heat necessary for converting food into body-building and energy-supplying elements.

HEART HORMONES

Various authors within the last year or two have proven that substances are present in the heart, continuously formed anew, which we may designate heart hormones. Loewi found that in the surviving heart, upon stimulation of corresponding nerves, substances are formed which produce vagus effects on other hearts. He considered his vagus and sympathicus substances as ester-like bodies which are rapidly decomposed by fermentative hydrolysis in the organism.

Dr. Haberlandt, Professor of Pharmacology in Innsbruck, Austria, has isolated from the unstimulated heart extracts with digitalis-like effects. The active substances, not as yet isolated in pure condition, are soluble in absolute alcohol, and are not proteins, insoluble in ether, and are not fats or lipoids; they are dialysable, stand boiling without damage in contrast to enzymes, and diffuse into Ringer solution from the isolated heart. These substances, as other hormones, are not specific for hearts of different species of animals.

Much progress may safely be expected from this earnest biochemical and physiological search for the very instigators of heart action.

II**Weakened Hearts**

A new order of vigor prevails today in the civilized world, states Dr. Dublin, the statistician of the Metropolitan Life Insurance Company. The control over the external infections, he continues, has resulted in a greater interest in the defects of our internal organism. Today the emphasis is shifting, however, from the infectious diseases of youth to the degenerative conditions of middle life, such as

heart disease, the hardening of the arteries, Bright's Disease (nephritis), the nervous disorders and cancer. There is good evidence that these conditions, taken together, are increasing. It is entirely possible that the way we now live has a good deal to do with the situation. The crowding of immense populations into the cities, their intense and noisy activity, the drive for money and for the excitements which money supplies are certainly not conducive to orderly and reposeful living.

HEART TROUBLE The "nervous heart," not a true heart disease in the strictest sense, according to Drs. White, of Boston, Massachusetts, and Myers, of Des Moines, Iowa, is the commonest disturbance of all. It represents the condition occurring frequently during convalescence from acute infectious diseases, *e. g.*, the influenza heart, the "pneumonia heart," operations and accidents.

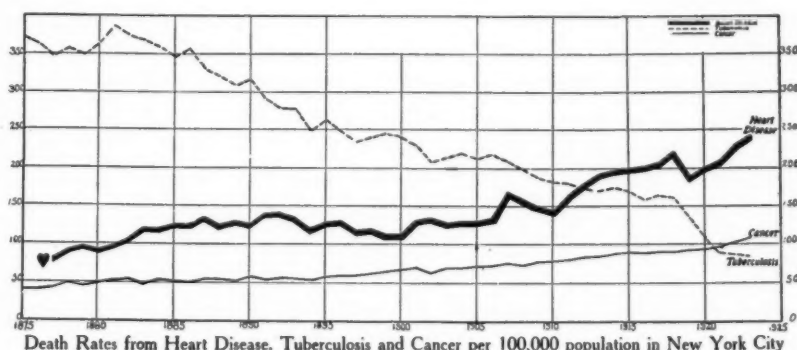


Fig. 6

HEART DISEASE Heart disease is listed first in the causes of death, and in the amount of harm and misery it brings through producing disability and invalidism. A recent weekly report of the Philadelphia Bureau of Health showed that the largest number (73) died of heart disease. With a growing record of at least 200 dead for every 100,000 of people in the United States from heart disease, the highest death rate of 250 for every 100,000 population in big cities, such as New York City, with more than 2,000,000 persons in this country suffering from it, heart disease has become the outstanding health problem. The long period of incapacity, due to this disease, causes a greater economic drain on the community than any other human affliction.

Certain very common disorders of the heart, recorded as functional, arise from difficulties outside the heart. Although we observe no change in structure, walls or valves, the heart is not working properly. The nervous system regulating the heart action may be temporarily disturbed by sudden noises, extreme bodily exercise, nervous exhaustion and overstrain, creating depressing symptoms, usually of no great importance—unless the disturbance continues and impairs the heart permanently.

Organic heart diseases involve some change in the heart itself and are much more serious disorders.

SYMPTOMS

To fix the symptoms which may be observed, Dr. T. St. Hart, former president of the Association for the Prevention and Relief of Heart Disease, asks those who have sound hearts to try the following experiment: Tomorrow when you are going downtown via the elevated railroad, start to run about two blocks before you reach the station, rush up the stairs as rapidly as possible and tumble into a seat on the train and proceed to observe your own symptoms: (1) you will be "all in" and feel a general sense of fatigue and weariness; (2) you will be conscious of a pounding, thumping heart, *i. e.*, palpitation; (3) you will be short of breath and puffy, *i. e.*, dyspnea; (4) if you count your pulse rate you will find it quite rapid, *i. e.*, tachycardia. These are the outstanding symptoms of a heart that is working in response to stress; fatigue, palpitation, dyspnea and tachycardia. In a few minutes your normal heart will recover its normal activity, fatigue will disappear, you will not be conscious of your heart action. Your breathing will be quiet, and your pulse slow. The functionally abnormal heart will develop the same symptoms, but the amount of effort which calls them forth is quite different. Slowly climbing half a dozen stairs may be sufficient to make all these signs evident, and they may not disappear for a long time. In a badly damaged heart these symptoms may persist even when the patient is making no effort and merely sitting in a chair or lying in bed. With the improvement of the heart condition it will require more and more effort to induce these evidences of a laboring heart.

CAUSES

Heart disease may be caused before birth (congenital), through faulty development of heart structures—or acquired after birth through an infection, through the

absorption of a toxic substance (food-toxin or poisonous metal), or finally through degeneration as a result of over-exertion, over-indulgence—and old age.

The congenital heart disease, while rather rare, in comparison with the number of other heart diseases, is comparatively frequent in certain children's heart clinics.

An examination of 856 adult patients as reported by the American Heart Association showed the following relative causes of heart disease:

Unidentified	10%
Various causes	15%
Rheumatism	25%
Syphilis	10%
Arterio Sclerosis	40%
(hardening of the arteries.)	

While many factors other than infection are the cause of heart failure in adults, infection is singularly considered as the cause of heart failure in children.

In the northern and eastern States, according to the review of about 1000 cases of heart disease by Dr. C. T. Stone of Galveston, Texas, rheumatic fever is less frequent, and the occurrence of rheumatic heart disease is correspondingly reduced. Hypertensive heart disease is the most common type along the Gulf Coast. In the clinic of the John Sealy Hospital, syphilitic heart disease is second in order of frequency, doubtless due to the large number of negro patients. Cases of rheumatic heart disease often occur in typical form without history of a preceding attack of rheumatic fever or chorea. Syphilitic heart disease is found most often in negro males in hard manual labor. It is distinctly less frequent in the white race and in females of the negro race.

**RHEUMATIC
HEART**

Rheumatic disease in the child is indeed a menace. Rheumatism, Dr. St. Lawrence, noted child specialist of New York, stated at the last annual meeting of the Heart Association, is the chief and perhaps the sole cause of heart disease in children. Like tuberculosis, it displays the same permanency with periods of quiescence and recurrence—and repeated examinations are necessary to ascertain that the infection has been

eliminated, no damage done and no disorder remaining. There is evidence, though not fully verified, that we are dealing in rheumatism with germs, or their poison, that attack the joints, the nervous system, the muscles, including the heart.

(1) Rheumatic fever is characterized by red, swollen and painful joints.

(2) Rheumatic heart trouble is usually acute—occurs early in life, and often affects the valve between auricle and ventricle on the left side.

(3) St. Vitus Dance (chorea) and growing pains are looked upon as rheumatic troubles leading to heart disease.

(4) It is considered likely that rheumatic germs enter the body through diseased tonsils, adenoids and decayed teeth. Removal of these conditions is therefore accepted as an effective measure.

A careful analysis of 478 cases of heart disease—reported by Dr. Morris Fishbein, the editor of *Hygeia* and other medical journals—showed that in 83 per cent. the condition developed before removal of the tonsils, and in only 17 per cent. after their removal.

SYPHILITIC HEART

The virus of the syphilitic disease frequently attacks the heart muscle in the later stages of infection, causing serious chronic heart trouble many years after the infection. People between forty and sixty are especially afflicted, according to Dr. Dublin; the aorta or aortic valve on the right side of the heart is affected. The affected valves in such cases become scarred and deformed and no longer function perfectly. The inflow of blood from one chamber to another may be impeded, or an incompletely closed valve may permit blood, once through, to leak back into the chamber whence it obviously came. To meet the body's needs, the heart must increase its labor under such conditions and ultimately the muscle will become exhausted. Frequently valvular disease is accompanied by certain unusual sounds called "heart murmur," or murmurs heard in the heart as the blood flows through from chamber to chamber.

ARTERIO- SCLEROSIS

As the various membranes of the normally elastic arterial tubes become inflamed and this inflammation becomes chronic, calcification, that is, hardening and crumbling of the walls (arterio-sclerosis) takes place. The largest

artery, the aorta, shows this inflammation first, and later almost all the arteries, in different degrees, become inflamed. The inner membrane of the arteries, according to Dr. R. Schmitt, Director of the Children's Clinic at Hamburg, Germany, becomes thickened by diffusion or flakelike deposited substances, but then undergoes a fatty metamorphosis and becomes softened. The blood, passing this softened inner membrane, causes the formation of ulcers which may again close up. The fatty degeneration now attacks the middle arterial membrane; this loses its elasticity and no longer adequately withstands the pressure of the blood, and the diseased arteries become elongated and twisted, changing their forms, and smaller arteries as a result, may burst, causing apoplexy and bleeding of the



Fig. 7

Calcified Main Artery (Aorta) With the Two Arteries of the Hips and Other Branch Arteries. (After Schmitt.)

brain. In the inflamed arteries frequently lime is deposited, hardening them and making them still less elastic. Primary calcification of arteries without inflammation is uncertain. The closing of arterial branches in brain, heart, spleen, kidney and of main arteries in intestines and mesenterium leads to the death of the tissue. The arteries may be frequently translocated as the walls become thickened and blood clots (thromboses) are formed, stopping blood circulation. Chronic arterio-sclerosis is a typical disease of elderly people. However, syphilis and gout bring calcification in younger years and even excessive smoking and drinking have a hardening influence upon the development of arterio-sclerosis.

Everything must be done by those who suffer from it to prevent great increase in blood pressure and the danger of bursting the arteries.

BRIGHT'S DISEASE Increased blood pressure (hypertension), the result of nephritis or of causes unknown, increases the load upon the heart, enlarges and degenerates the heart muscle, without involving as a rule the valves in the beginning of the trouble. This disease, according to Dr. Dublin, is chronic and occurs mostly in old people and in persons after fifty years of age.

ANGINA PECTORIS If the normal blood supply through the coronary arteries is not available, on account of the degeneration and decrease in size (arterio-sclerosis) of coronaries and arteries, or if, through some disturbance of the general metabolism the heart is not properly nourished, the trouble recognized as angina pectoris, oppressive pain, accompanied by fear, frequently results. Finally death occurs, if the coronaries become plugged and the heart starves.

BACTERIAL INFECTION OF HEART MEMBRANES (ENDOCARDITIS) This disease, according to White and Myers, is due to the invasion of known organisms mainly of the round coccus type and includes the coccus of gonorrhoea and the influenza bacillus. Depending upon the virulence of the organisms, the infection may last days or months or may be fatal, being often not recognized clinically.

OTHER INFECTIOUS HEART DISEASES Scarlet fever heart, according to these authors, is also referred to as rheumatic heart disease. Diphtheritic heart disease is usually fatal. Tubercular heart disease is rare.

GLANDULAR HEART DISEASE Thyroid heart disease may occur incident to insufficient or excessive excretion of the thyroid glands.

TOXIC HEART DISEASE Toxic conditions may be caused by metallic poisons, uremia, possibly nicotine from tobacco, caffeine from coffee and absorption of toxins from local infections. As the poisons are usually slowly absorbed, it is highly important, according to Dr. Wyckoff, to eliminate the poison through improved digestion and to constantly guard against the entrance of outside poisons such as lead, alcohol, nicotine.

**OVERSTRAINED
AND SENESCENT
HEART**

Excessive athletic exercise may cause the "athletic" heart, excessive beer drinking the "beer" heart, extreme obesity may cause other not well-defined discomforts and trouble. The senescent heart, merely through the degenerative changes in the heart and blood vessels, and not necessarily through any local disease process, refuses to function properly and finally stops entirely because the cells can no longer be regenerated.

III

Treated Hearts

GENERAL CARE

It is quite certain, said the British authority, Sir Arthur Newsholme, that a high proportion of the total deaths due to heart disease are preventable, the best way to diminish it is to double public health expenditure, wisely directed toward increased child hygiene, increased school hygiene and increased adolescent hygiene.

In 1921 there was expended in the United States an average per capita of \$10 for candy, \$9 for education, fifty cents for chewing gum and twenty-nine cents for health.

In the majority of instances, says Dr. Hart, heart disease under suitable management is not progressive. Even if a valve has been injured beyond the possibility of complete repair, proper care may prevent further mischief, and compensating factors may be developed which allow the heart to perform its work efficiently in spite of its handicap.

A number of those having heart disease make a complete recovery and regain health. There are others with damaged hearts who would suffer very little or no incapacity if they would secure good advice and adapt their mode of life to accord with the rules which long study and wide experience have proved effective.

There is altogether too much pessimism in regard to heart disease, suggests Dr. Hart, and pleads that if we are to secure the best results in our patients we must instill them with hope. A patient who is confident of his prospective improvement is far more likely to reach that goal.

There are a number of heart abnormalities that cause much worry and distress which may completely disappear. Such, for example, are certain irregularities as those caused by the excessive use of tobacco. There are on record a certain number of congenital de-

fects, which time has cured. The number is enormous, he concludes, of cases of established heart disease which either never show any functional failure, or which, having once failed to carry on, can under suitable conditions be brought to a high degree of efficiency.

No one else can do so much for your heart as you can, says the Metropolitan Life Insurance Company. Keep it healthy by going to your doctor for a health examination, by looking after infected tonsils or teeth, by eating the right amount of the right foods, by keeping your body weight near the health average, by not over-using tobacco or stimulants.

HEART RULES

The Chicago Heart Association suggests the following fundamental rules in the treatment of heart disease:

Every person with organic heart disease should limit his physical activities. He should consult his physician for a detailed plan.

Amusement and work must be chosen with a view to these limitations.

He should try to avoid situations which are likely to induce emotional excitement.

A person with organic heart disease should spend not less than ten hours out of every twenty-four in bed.

A vacation with relief from work and worry is a good thing for everyone, especially for the cardiacs (those who suffer from heart disease).

A simple, plain diet, containing a variety of foods, is best fitted to his needs.

Unless ordered for him by a physician, he should not use stimulants, such as tea, coffee, alcohol and tobacco.

CONVALESCENT HEARTS

Heart disease has so many grades and is so prevalent in all the zones of life that surely considerable numbers should be convalesced regularly in the larger standard homes, along with others.

Three examples of feasibility are suggested by Dr. Frederic Brush, Medical Director, The Burke Foundation, White Plains, N. Y.

(a) Those with fair compensations and reserves should not (as now) be refused because labeled "Heart disease," a "murmur," etc., when needing (as so often) convalescence for other reasons, or merely general upbuilding.

(b) Those who just "tire on the job" frequently, with fairly holding compensations, should be given periodic rests, and in this way kept in productive life.

(c) Youth should be given first place in cardiac convalescence, and more beds opened to them. Youth is to be the main point of attack on heart disease. Recent experiments of the Burke Foundation and others show, apparently, that country convalescence of cardiac youths is surprisingly successful, and without very special equipment or precautions.

These three phases have been entered on. Cardiacs recovering from recent attacks should not be sent early to standard convalescent homes. They relapse too frequently. Prolonged hospital or house care and follow with ambulatory attachment to "Cardiac clinics," and occupational supervision is to be provided.

SPECIFIC CARE

The most important relief in the treatment of acute or chronic heart disease, from other than drugs, comes, according to Dr. White, from rest and mental and physical recreation, from wise exercise, favorable climate, friendly psychic treatment on part of physician and nurse, right physical therapy, adequate regulation of diet and fluid ingested, from successful surgical intervention and venesection.

It seems so strange, says Dr. John Wyckoff, that one patient having heart disease is ordered to exercise, while another one is advised to take absolute rest, although the symptoms in both patients may be similar or even the same.

This can be made clear from the following example, using normal athletes as an example. Three healthy young men enter college at the same time. At the time they enter all three are able to climb four flights of stairs without breathlessness. A becomes very interested in his studies and, although he has previously led a very active life, now leads a sedentary life and takes no exercise. B goes into training for cross-country running and under proper training takes a proper amount of exercise. C leads a life similar to the one they had all lived before entering college. At the end of three months A becomes breathless on climbing a single flight of stairs because he has had too little exercise. C still can climb four flights without breathlessness; but B, who has been training, can now climb six flights before he notices shortness of breath. In other words, B has in-

creased the ability of his heart to do work, by proper exercise. Now let us take our illustration a little farther. B is so enthusiastic over his athletics that he over-exercises and soon he finds that he is getting breathless at four flights; he thinks this is because he is not doing enough exercise and he works all the harder; but to his chagrin, after a few weeks his condition is as bad as A's, he gets breathless now after two flights. The trainer tells him he is "stale," but what has happened is that he has given his heart too much to do. In order to keep a normal heart at its highest efficiency a proper amount of exercise and rest is necessary. This is also true of the diseased heart.

Fine judgment is frequently needed to determine whether a diseased heart needs more or less exercise. Some patients with heart disease should not exercise at all, others need considerable exercise, and this can only be determined by careful study of each case by a physician of experience.

MEDICATED HEARTS

It is much easier to write upon a disease than upon a remedy, wrote the English Dr. Withering way back in 1785. "The former is in the hands of nature, and a faithful observer, with an eye of tolerable judgment, cannot fail to delineate a likeness. The latter will ever be subject to the whims, the inaccuracies and the blunders of mankind."

In derangement of circulation, the intelligent application of medicinal measures is pointed out by Drs. Levy and Mackie as an important factor in initiating improvement; their timely use is frequently held responsible for the saving of life.

ALCOHOL

A little wine—said President Dr. Samuel Waldron Lambert of the New York Academy of Medicine to colleagues, assembled at a recent conference on old age—for the stomach's sake represents a real therapeutic result, it has an action not on the stomach but on its nearest neighbor, the heart. Alcohol is not a direct stimulant but acts directly as an antidote to the chronic poisoning of the heart from over-indulgence in coffee and tobacco. Alcohol, by its rapid absorption without the necessity of previous digestion, by its action to increase the amount of blood circulating in the capillaries of the skin, gives a feeling of distinct warmth and comfort to the aged. It is particularly true in the diabetes of old age

(brought about by greatly increased sugar consumption—in want of the rapidly oxidizable, prohibited, food alcohol) that alcohol has a useful and prominent place in the treatment of disease.

**DIGITALIS AND
DIGITALOID
DRUGS**

One of the most important drugs in the *materia medica* is *Digitalis*, the beautiful red foxglove, introduced by Dr. Withering from folklore's mysterious concoction to physician's stand-by medicine.

Digitalin and physiologically similar (*Digitaloid*) drugs, *e. g.*, *strophanthus*, *squill*, *convallaria* (lily of the valley) and *apocynum*—have the recognized main actions.

Main action of *Digitaloid* drugs (according to McGuigan):

1. Specific stimulating action on heart, rendering it more irritable, with tendency to more rapid action.
2. Stimulation of vagus nerve center tending to slow the heart.
3. Stimulation of the vasoconstrictor center, causing constriction of the blood vessels.
4. Direct stimulation of musculature of the vessel particularly strong in the visceral (splanchnic) region.
5. An irritant action on the stomach or wherever applied.
6. A tonic action on the central nervous system.
7. A tonic action on the inner lining (endothelial) and lymph conveying tissues.
8. A direct stimulating action on the vomiting center.
9. A marked increase, through changes in the blood circulation, of urine excretion in cases of certain swellings (*œdema*) in the connective tissue.

The chemistry and physiology of the representative member *Digitalis* has been a most difficult and trying problem. From recent progress made both for the seeds and the leaves, and from the serious efforts made in various sectors of the world to conquer the difficulties, we may expect soon rather a complete solution. The seeds yield digitalin, possibly identical with bigitalin, digitalein, possibly a mixture of bigitalin and gitalin, and according to my own findings only traces of digitoxin; the leaves contain, according to latest reports—digitoxin, bigitalin, gitalin and possibly also their products of decomposition (hydrolysis), the genins, and sugars.

ACTIVE SUBSTANCES OF DIGITALIS

— LEAF —

Substance (Glucoside)	Molecular Composition	Melting Point	Split Product	Molecular Composition	Melting Point	Molecules Sugar	Molecular Composition	Melting Point
Digitoxin	$C_{44}H_{70}O_{14}$	252°	Digitoxigenin	$C_{24}H_{36}O_4$		2	Digitoxose $C_6H_{12}O_4$	110°
Bigitalin	$C_{40}H_{64}O_{14}$	282°	Bigitaligenin	$C_{22}H_{34}O_5$	232°	3	Digitoxose $C_6H_{12}O_4$	110°
Gitalin	$C_{17}H_{28}O_6$	245°	Gitaligenin	$C_{11}H_{18}O_3$	222°	1	Digitoxose $C_6H_{12}O_4$	110°
— SEED —								
Digitalin	$C_{37}H_{58}O_{14}$		Digitaligenin	$C_{24}H_{32}O_3$		}	Digitalose $C_6H_{12}O_{16}$	
Digitoxin	$C_{44}H_{70}O_{14}$	252°	Digitoxigenin	$C_{24}H_{36}O_4$			2 Digitoxose $C_6H_{12}O_4$	110°

**STANDARD-
IZATION**

The large variation in the amount of active constituents in commercial crude samples and preparations require a definite checkup, "assay." Chemical assay methods are not as yet feasible. The biological test, as ascertaining the strength by the use of animals, "although far from ideal"—as pointed out by Drs. Levy and Mackie and others, is more and more accepted as a worthy check. The pulsations of the strong, weakened and medicated hearts may be readily recorded on the kymograph, provided with a rotating smoked drum.

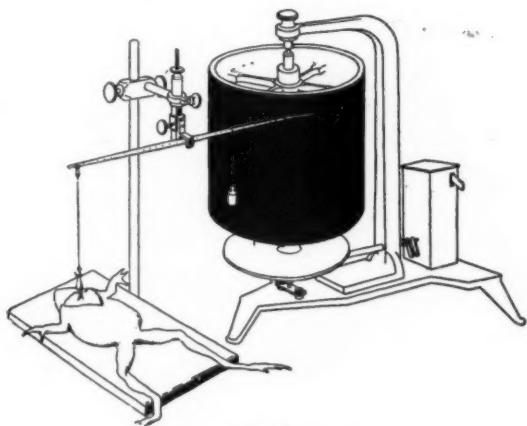


Fig. 8

Suspension Method of Recording Heart Contractions.
(After Abderhalden.)

The various animals have been proposed:

1. FROGS

- (a) Used in the "one hour method" official in the U. S. Pharmacopœia and National Formulary, for heart stimulants, determining the smaller dose of the drug (per gram weight of the frog) causing permanent contraction of the heart chambers (ventricle) at the end of an hour.
- (b) Recommended by Houghton in the twelve hour method, determining the smallest amount per gram body weight causing death of the animal within 12 hours.
- (c) Suggested by Focke in his method determining the dose and time required between 7 and 15 minutes to stop contraction of the exposed heart upon injection of the infused leaf into the sac of each leg.

- (d) Used in the perfusion method, determining the effect of the test solution upon the exposed heart, suspended by the tip and connected with a lever permitting a graphic record of the movement of the heart on the smoked drum of a Kimograph (see Fig. 9).

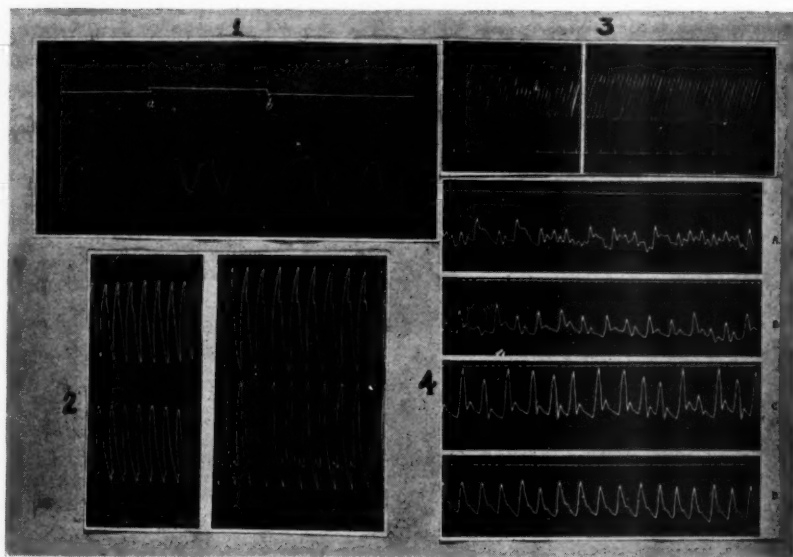


Fig. 9

1. Direct Stimulation of Isolated Rabbit Heart. Stimulation at a., in Beginning of Contraction, Systole, Ineffective. Stimulation at b., in the Midst of Relaxation (Diastole) Causes Extra Contraction. (After Langendorff.)

2. Dog's Heart Before and After Injection of Digitoxin Into the Veins. Cardiographic Tracings of Ventricle (Highest). Cardiographic Tracings of Auricle (Middle). Cardiographic Tracings of Blood Pressure (Lower). The Heart is Lowered (From 205 to 165), Contraction is Increased While Relaxation is Less Increased. Blood Pressure Shows a Slight Rise. (After Cushing.)

3. Rabbit's Heart, Before and After Treatment With Digitoxin, Improving the Irregularity (Extra Contractions). (After Gottlieb and Magnus.)

4. Record of Irregular Human Heart, Before and After Treatment With Digitaline. a. Pulse Before Treatment; b. After Four Days Treatment; c. After Nine Days Treatment; d. After Seventeen Days Treatment. (After Pfaff.)

2. GUINEA PIGS

Recommended by Reed and Vanderkleed and made official for the testing of heart depressants, determining the smallest dose per gram body-weight, injected under the skin, stopping the heart within 6 hours.

3. CATS

Suggested by Hatcher & Brady, in their method determining the smallest dose per kilogram of cat injected into a vein in the leg or thigh, stopping the heart.

4. GOLD FISH

Proposed by Pittenger and Vanderkleed, determining the smallest amount of digitalis tincture in 500 cubic cc. meters of tap water at 22 degrees Celsius—which proves fatal to goldfish within 3 hours.

**5. DAPHNIA
(WATER FLEA)**

Suggested by Arno Viehovever and under further investigation, determining the quantitative effect of digitalis—extract and isolated active substances upon the heart action, directly visible under the microscope—and the smallest amount, causing permanent stopping in a given time unit under controlled conditions.

The belief has been expressed that the heart hormones found in the center of the rhythmic movement act similarly to digitalis glucosides or vice versa. The isolation of pure substances will greatly facilitate the study. It is now under way.*

In the meantime fruitful work has been done with another hormone, adrenaline, isolated from the suprarenal glands. It hastens heart action on account of the great contraction of vessels. The amount of blood, pressed out of the heart, is much below normal; .0,000,000I of adrenaline is said to contract the arteries of the heart. The effect of one injection is of rather short duration—and ephedrine, the base isolated from an old Chinese herb medicine, Ephedra, has recently been substituted on account of its prolonged action.

The revivification of a weak or even dead heart belongs in the most interesting chapters of medical treatment, though the results thus far have rarely, if ever, been lasting.

RESEARCH

"The work of man's redemption of man is yet incomplete." There is clearly a call, believes Dr. Dublin, for a revaluation of the effort now being expended on the study of heart diseases, and for the statement of a program of research, . . . commensurate with the importance of these diseases as sources of preventable or postponable death. The most im-

*The author has been supported in the work on heart medicines by grants of the American Pharmaceutical Association and the Kilmer Research Fund, made available to his student coworkers. Additional funds would greatly help speedier progress.

portant need at the present time, states Harry L. Hopkins, of New York, in his "Cardiac Program in a Large City," is much more definite information in reference to heart disease, and for this reason a very considerable part of the Heart Committee's budget is used for

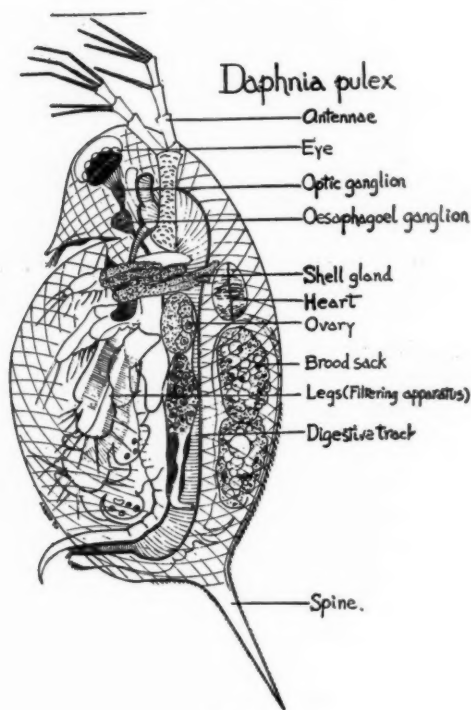


Fig. 10.

research work, guided by the Committee on Research.

Informed of the complexity of heart troubles and diseases, of the need for further data all along the line, of the serious and rapid increase in heart failures, humanity, as a whole, should join hands in encouraging and supporting the most extensive study of the trying unsolved problems, for its own sake.

Outlook

Statisticians will pile up further useful data to demonstrate and reiterate that heart disease is our outstanding health problem, the leading cause of death.

However, enough information is already at hand to impress upon everyone, child, adult, the aged, the ever-present danger of heart trouble—and the need for sound living, for preventive and curative medication.

The educational work, so effectively set into motion by the Heart Association, will likely increase, as will the helpful work of the heart clinics and individual practitioners.

Behind the stage will be the workers, trying to solve all pending problems of causes and effects upon the heart, the experimenters trying to gain further insight into the intricate structure, to obtain further knowledge of its interrelated activities and better understanding of its magic power of adjustment—all doers eagerly searching for the master key—the key to gain entrance to the living heart of man—and thus to the very heart of life.

THE WELLCOME HISTORICAL MEDICAL MUSEUM and ITS FOUNDER

By Joseph W. England, Ph. M.

PROBABLY THE MOST unique institution of its kind in the world is the famous Wellcome Historical Medical Museum at 54 Wigmore Street, London. It was founded in 1913 by its director, Henry S. Wellcome, LL. D. (University of Edinburgh).

Dr. Wellcome graduated at the Philadelphia College of Pharmacy in the same class with his lifelong friend, Dr. Frederick B. Power, and later on the College honored him with the degree of Master of Pharmacy.

The collections in this museum are international in character, covering medicine, surgery, chemistry, pharmacy and the allied sciences, and some of the objects date back to more than 3000 years B. C.

The Conservator, Mr. L. W. G. Malcolm, M. Sc. (Cantab), F. R. S. E., writes in the museum handbook as follows:

“The Wellcome Historical Medical Museum is designed to represent the history of the various branches of the art of healing throughout the world, their practice being illustrated by objects, instruments and appliances of historical interest, and by plastic and pictorial art.

"Medicine has a history which has reached every phase of life and art, and is, to a great extent, bound up with the records of human existence from the earliest times. By its study, fresh fields of medical research are suggested and the interest in others, still undeveloped, is stimulated.

"Our views of progress, especially in regard to medical treatment, are often exaggerated, owing to our ignorance of the past; and careful research into ancient records has revealed the fact that modern methods are often mere repetitions of those practiced in the long past ages. Through the study of medical history, important discoveries have been made, and information of great value, forgotten and buried in the records of the distant past, have been brought to light."

A very important department of this Museum is the Technical Library, containing more than one hundred thousand volumes, including a great number of ancient manuscripts, incunabula, early printed works, etc. Another important department is concerned with sculpture, oil paintings, prints, engravings, etc., etc.

It is impossible to detail here the many thousands of rare objects exhibited in the Wellcome Museum, but the collections are so comprehensive in character that they deserve special reference.

The following is merely a brief synopsis of the material in general exhibited in the various sections:

The Hall of Primitive Medicine relates to the primitive medicine men, primitive treatment, primitive secret societies, effigies, ancestor cults, charms, amulets, talismans, magical procedure, artificial deformation of the body, etc.

The Anatomical Section contains paintings, sculpture, drawings and objects of exceptional anatomical interest, such as rare figures in wax and ivory for teaching anatomy in the sixteenth and seventeenth centuries, also the works of William Harvey (1602) and Vesalius (1502), etc., etc.

The Hall of Statuary contains exhibits of many statues of the deities of healing, including Cheiron the Centaur, Father of Botany and Pharmacy. Also there are extensive exhibits of surgical and dental instruments and appliances illustrating the development of medical, surgical and dental practice and procedure from the time of primitive man and throughout the Oriental, Assyrian, Egyptian, Greek, Roman and mediæval culture periods.

The Hall of Alchemy illustrates the history of alchemy from remote times and contains most fascinating collections of ancient

alchemical apparatus, models, manuscripts, drawings, etc., indicating the stepping stones that have led to the development of modern chemistry.



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I-EM-HETEP (Imhotep), Egyptian Deity of Medicine. A Contemporary of Zoser, IIIrd Dynasty, Circa 2980 B. C.

The Section of Physics and Chemistry illustrates the evolution of the microscope from the earliest times and is probably the most complete collection of its kind in existence. It includes a full series of ophthalmic instruments, optical apparatus, evolution of the spectacle, acoustical instruments, electrical instruments, electro-therapeutics, historical periods of chemistry, drugs from ancient times to the nineteenth century, etc., etc.

The Portrait Gallery contains portraits of eminent men of the medical and allied sciences, and associated with them are the instruments and appliances which they originated or used, together with manuscripts and printed works recording their discoveries and achievements. Dr. Edward Jenner, the discoverer of vaccination, is represented by contemporary portraits at various periods of his life and activities, together with his original instruments, appliances, drawings, manuscripts and many personal relics. In a similar manner William Harvey, the discoverer of the circulation of the blood, and



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An Original Turkish Drug Shop, XVIIth Century, Wellcome Historical Medical Museum.

John Hunter, the great anatomist, are represented. The Duke of Wellington, Lord Nelson and George Washington and other notable historical figures are represented by documents and by medical and surgical objects employed by their chief medical attendants.

The Lister Section contains a complete model of the famous Lister ward at the Royal Infirmary, Glasgow, in which Lord Lister carried out his researches, made his historic discoveries and put into practice his epochal principles for the antiseptic treatment of wounds

in 1865. There are also exhibited his original personal apparatus, instruments, etc., invented and used by him in his researches, also his original manuscripts, materials and personal relics. An important feature of this exhibit is a complete original section of the Lister ward exactly as it existed when Lister carried on his operations, together with the actual original furniture and equipment. This section was secured by Dr. Wellcome and transferred to this museum when the ancient infirmary building was demolished some years ago.



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An Italian Pharmacy, XVIth Century, Wellcome Historical Medical Museum.

Very appropriately associated with the Lister section is a collection of original apparatus, appliances and materials with which Louis Pasteur carried out his historic researches and made his great discoveries which led up to and facilitated Lister's investigations in antiseptic surgery when these two great masters of science clasped hands and recognized each other's great achievements.

The Obstetrical Section exhibits a birth chamber of the sixteenth century and various obstetrical appliances employed from a remote period up to the present time.

The Pharmaceutical Section is of particular interest with its original sixteenth century English alchemical manufacturing laboratory; a London chemist's shop of the eighteenth century, this being the original famous pharmacy established by 1798 by John Bell, the father of Jacob Bell, the Quaker founder of the Pharmaceutical Society of Great Britain; a London apothecary's shop of 1625; and an Italian pharmacy of the sixteenth century; a model of a native Chinese drug shop; an original Turkish drug shop of the seventeenth century, from Constantinople. There is an extensive collection of materia medica specimens dating from ancient times to the present; a vast number of pharmacy jars and other pharmaceutical ware, numerous examples of chemical and pharmaceutical apparatus from all parts of the world

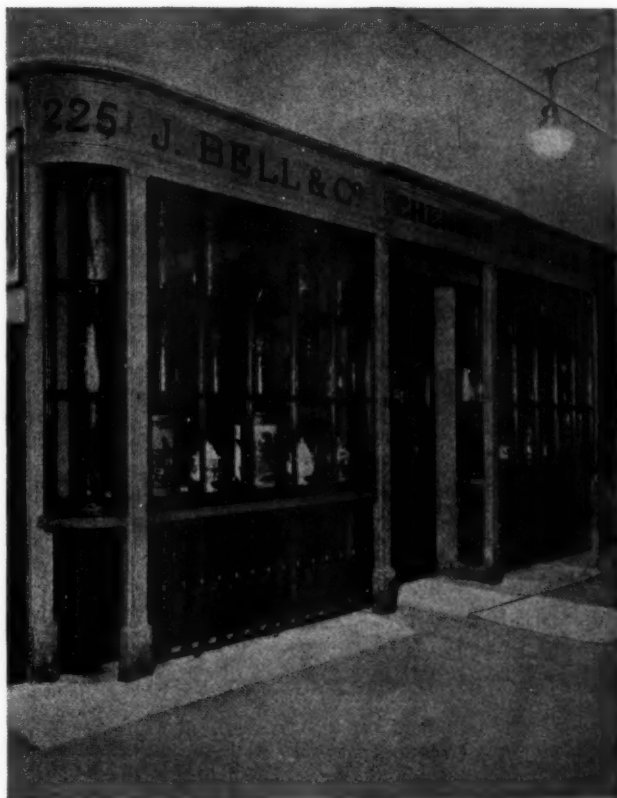


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An Apothecary's Shop, 1625, Wellcome Historical Medical Museum.

illustrating the history of pharmacy. A very complete collection of pharmacopœias of all countries and all periods. Included among a large number of herbals is shown an original Papyrus Herbal which is the earliest one known to be in existence.

The War Section includes selected objects relating to war surgery, orthopedics, nursing, the military ambulance, etc. This section is very extensive and includes very remarkable models of subterranean field hospitals and dressing stations, also complete ranges of naval and military medical and surgical equipments employed in various campaigns and during the great war, in practically all the fields of operations.



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A London Chemist's Shop, XVIIIth Century, Wellcome Historical Medical Museum.

The foregoing notes give but a meagre idea of the vast scope of this Museum.

Our trip through the Museum in August, 1928, under the gracious guidance of Dr. Wellcome himself, was one of the red-letter days of our lives. It made us feel proud of the splendid growth and develop-

ment of our sciences and arts, and of Dr. Wellcome for originating such an important enterprise and carrying it on so successfully at the sacrifice of much of his time during many years, and his great expenditure of money. All honor to him in the name of Pharmacy! He has done a great work, one that will live long after him and bring great credit to our craft.

Such a museum constitutes research work of the finest type. We gain new knowledge by studying old and forgotten knowledge by the light of modern methods. Not only has Dr. Wellcome put his



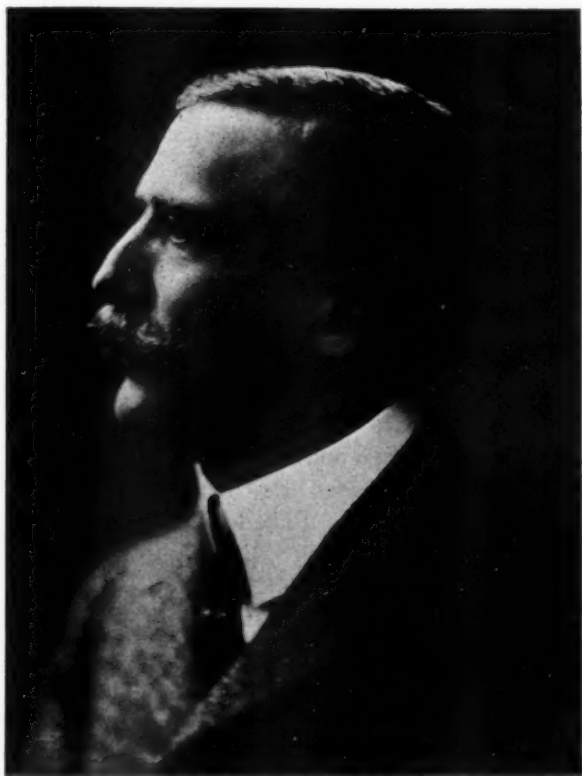
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Part of the Hall of Primitive Medicine, Wellcome Historical Medical Museum.

whole heart and soul into research work for the creation and development of this museum, but he has also established in London a great "Bureau of Science Research" with separate affiliated Physiological, Chemical, Bacteriological and Entomological Laboratories; also, on entirely original lines, an extensive Museum of Medical Science (including tropical medicine and hygiene), where not only research workers resort for information, but where teachers of the great medical schools of London bring their classes to visualize and demonstrate to their

students the actualities of the latest discoveries in these fields of medical science.

Immediately after Lord Kitchener's reconquest of the Anglo-Egyptian Sudan in Africa, Dr. Wellcome founded the Tropical Research Laboratories at the Gordon Memorial College, Khartoum, and a fully equipped auxiliary Floating Research Laboratory on the Upper Nile, which have conferred immense benefits on the sick and suffering humanity of those tropical regions in the heart of Africa.



HENRY S. WELLCOME,
Founder of the Wellcome Historical Medical Museum.

It should be noted that each of these museums and research institutions above referred to are carried on under separate and distinct management and are quite apart from Dr. Wellcome's chemical industries; but that he continues to act as governing director of the "Wellcome Foundation" and as president of Burroughs, Wellcome & Company (Inc.).

Henry S. Wellcome

Henry Solomon Wellcome, the son of a clergyman, was born in Wisconsin, in the region of the Chippewa and Menominee Indian tribes. When about five years of age he, with his parents and a party of several other families, migrated westward, trekking across the wild open country by day in covered wagons, called prairie schooners; they halted, corralled and camped at night. Their destination was Garden City, a small but thriving frontier settlement in Minnesota, located between the Sioux and Winnebago Indian tribes, in "The Land of Hiawatha," not far from "The Falls of Minnehaha, the Merry Laughing Water," and near to the sacred Red Pipestone Quarry, where the tribal pipes of peace were wrought. The environment was inspiring and primeval nature fair to see. The strenuous unconventional frontier life presented many delightful experiences and happy associations, but also involved many severe hardships and grave difficulties which required the utmost fortitude to surmount.

Wellcome's primary education at Garden City was first in a typical frontier log schoolhouse, but as the pioneer settlement prospered, superior buildings were erected and higher grade schools established.

When but seventeen years of age he became an employee in Poole and Geisinger's Pharmacy, Rochester, Minnesota, and after two years' service went to Chicago and took a position in the pharmacy of Thomas Whitefield, and attended the Chicago College of Pharmacy for one year; then came to the Philadelphia College of Pharmacy, matriculated and was graduated in 1874, the subject of his thesis being "Urethral Suppositories."

After graduation he took a position with Caswell, Hazard & Company, of New York, and two years later accepted an important position with McKesson & Robbins, who sent him on special missions to various parts of the United States, Mexico, Central and South America. While in South America he studied the native cinchona forests, his account of which was read before the American Pharmaceutical Association and published in its Proceedings. He early recognized the unique industrial and commercial advantages of London as the greatest distributing and financial center of the world, and discussed the subject with his friend Silas M. Burroughs (P. C. P., Class of 1877), who offered to enter into partnership with him to establish a chemical and pharmaceutical works in England. Wellcome then resigned his position with McKesson & Robbins, and the firm of

Burroughs & Wellcome was founded in London in 1880 (Burroughs died in 1895), and today it is internationally famous in its field.

Wellcome "has always been an indefatigable student, unceasing in his quest for knowledge, and a strenuous, systematic worker. Personally he is modest and unassuming, genial and kindly, and leads a simple though busy life. He is magnanimous in promoting scientific research and worthy benefactions. As a pioneer in welfare work, he has provided clubs and institutions with technical instruction, and a park, sports fields, and gymnasiums for the educational and social betterment of his staff and employees generally. For years he has enjoyed the close friendship of many eminent men in the various fields of science and public life in America and Europe. He has done much to promote a better understanding between the United States and the British Empire. He was a founder and the second president of the American Society in London, which has for many years rendered valuable service in fostering cordial relations between the English-speaking peoples. During the South African War he bore the entire cost of the medical and surgical equipment of the American hospital ship 'Maine.' In 1903 the Philadelphia College of Pharmacy conferred upon him the honorary degree of Master in Pharmacy, and in 1905 he presented to his Alma Mater a massive gold-plated silver loving cup for award to successive classes for excellency of record in scholarship." (From "The First Century of the Philadelphia College of Pharmacy.") He had conferred upon him on June 28, 1928, the degree of Doctor of Laws by Edinburgh University, in recognition of his services to science and medicine, his interest in missionary enterprise, and his personal work in medical, chemical and pharmaceutical research, the history of medicine, archæology and geographical exploration.

From the beginning of his career, he has made original scientific research and strictly ethical methods the foundation of his life work. Apart from the research and experimental laboratories of his own firm, which have made an exceedingly large number of original investigations, he has established several scientific institutions under separate directions, but co-ordinated. The directors and staffs of these institutions are men of high attainments and of wide scientific repute. Among the institutions referred to are: (1) The Physiological Research Laboratories, Langley Court, Beckenham, Kent, near London, founded in 1894; (2) The Chemical Research Laboratories, 6 King Street, London, founded in 1896; (3) The Bureau of Scientific

Research, 25-26-27 Endsleigh Gardens, London, and the Auxiliary Entomological Research Laboratory, at Witley, in Surrey, founded in 1913; (4) The Museum of Tropical Medicine and Hygiene, London, founded in 1913; (5) The Historical Medical Museum, 54-A Wigmore Street, London, founded in 1913; (6) The Wellcome Tropical Research Laboratories, Khartoum, A. E. Sudan, Africa, and the Auxiliary Floating Tropical Research Laboratory in the Upper Nile, founded in 1902.

Percy F. Martin in his masterly work on "The Sudan in Evolution," 1921, (a study of the economic, financial and administrative conditions of the Anglo-Egyptian Sudan), writes:

"It would, perhaps, be too much to expect all those who have criticised Mr. Wellcome's liberal expenditure of his energy and money on research work in the Sudan to understand his lofty aims and unselfish purposes, or to appreciate the vast benefits to science and to mankind which have already resulted, and which must result in the future. An eminent traveler of wide learning who visited the Sudan several years ago was so impressed by the work of the Wellcome Tropical Research Laboratories at Khartoum that he wrote as follows: 'It is the beginning of a work comparable in importance to that of the great Portuguese travelers and explorers of the fifteenth and sixteenth centuries. Prince Henry the Navigator, Vasco de Gama, and Bartolomeo Diaz laid open the coasts of Africa to the exploitation and commerce of Europe, but through all the intervening centuries the interior of the Dark Continent has remained inhospitable and deadly. It seems as if modern science and hygiene may in a sense restore it to civilization and render it habitable and wholesome for the northern races. And in this great peaceful reconquest of the South, the Wellcome laboratories at Khartoum will be in the vanward files. If Britain had done no more in the Sudan than to provide a secure centre for this scientific work, we should have justified our efforts to get back to the Upper Nile.'"

Next to his love of original research in pharmacy, chemistry, medicine and allied sciences, he has been a keen student of archæology during the past nineteen years. He has discovered several important prehistoric Ethiopian archæological sites in the Upper Nile region, to the west of Abyssinia, and has carried out under personal direction extensive excavations and researches at those sites with fruitful results. In this work he has employed a technical and administrative staff of twenty-five Europeans and more than 3000 native workmen, and the results obtained "have thrown an unexpected light on early

Ethiopian history in this region, and for the first time has made scientific archæological records of a site in the interior of Africa" (Prof. G. A. Reisner, of Harvard University, the greatest living authority on Oriental archæology). And not only has Dr. Wellcome unearthed the dead past, but he has done more. He has established industrial schools and has taught the descendants of these ancient peoples to farm by the light of modern methods, he has enabled them to earn money, he has taught them to save, and he has established local banks for them, so that they need no longer live lives desperately fought for, from day to day, but enjoy the comforts of modern civilization and the self-respect that comes from hard work and individual development.

TRANSLATED ARTICLE

MICROCHEMICAL CHARACTERIZATION OF DRUGS *

By L. Rosenthaler, Berne

IN THE DESCRIPTION of drugs, as given in manuals and in Pharmacopœias, the microchemical characterization plays little or no part. In the Pharm. Helv. IV it appears relatively seldom, as in the case of a few oxymethylantraquinon drugs and several alkaloids. In some cases, as with opium, the liquid not used for the determination is used for identification by reactions. Yet there can be no doubt that microchemical characterization of drugs should not receive less consideration than the morphological-anatomical test, inasmuch as we use them on account of their chemical constituents. If the chemical characterization has thus far fallen so much behind in relation to the morphological-anatomical, the reason is mainly due to the fact that there is frequently lack of methods, especially of sufficiently simple ones. In some cases sublimation methods are the more appropriate as worked out by O. Tunmann ¹ (whose early death is much to be regretted) and by myself.² Processes are to be preferred that do not

*From *Schweiz. Apothek. Zeit.*, 1924, March 1, 8, 15.

¹ *Ber. Deutsch. Pharmaz. Gesell.*, 1911, 21, 312.

² *Ibid.*, 1911, 21, 338.

require special apparatus, especially those which can be carried out on a slide. In the following statements which the chemical characteristics of alkaloidal drugs are treated, mention is made of a number of such processes. The ideal, namely to undertake the chemical characterization exclusively on a slide, has of course not been fully attained. Particularly in the case of "leaves" other processes are necessary.

For the identification on a slide the following method of procedure has been often adopted: The powdered drug is moistened³ with a little water, covered with a cover-glass and raised a little at one side so that it is oblique. The space between the slide and the cover-glass is filled with ammoniacal-chloroform.⁴ After this has evaporated the alkaloids are found below the powder and frequently at the edge of the cover-glass. They may be identified through appropriate reactions. Color reactions have been more frequently used than was originally intended, since the formation of crystalline precipitates frequently involved difficulties. The process just described will hereafter be called "the treatment with ammoniacal-chloroform on a slide."

In those cases in which the process cannot be carried out on the slide, the method of procedure was often as follows: The powdered drug was slightly heated with 5 cc. of ammoniacal-chloroform in a test tube. This was filtered into another test tube and brought to a state of dryness on a steam-bath. The residue was used for the reactions. This method of procedure will be styled hereafter "the treatment with ammoniacal-chloroform in a test tube."

Cortex Cinchona. Heat 5 mgm. of the powder with several drops of a solution of 2 gms. of caustic soda in 100 gms. of 50 per cent. alcohol upon a slide, after having covered with a cover-glass. Replace the evaporated alcohol with water. After cooling, numerous crystals are to be seen: little rods, in part isolated, in part crossed or forming bunches, penicillated or double penicillated structures (see diagram 1). These crystals are the cinchona alkaloids.⁵ If they are then treated with diluted acetic acid, warmed, and a drop of a 1 per cent. iodic acid solution added, or better, a small grain of iodic acid.

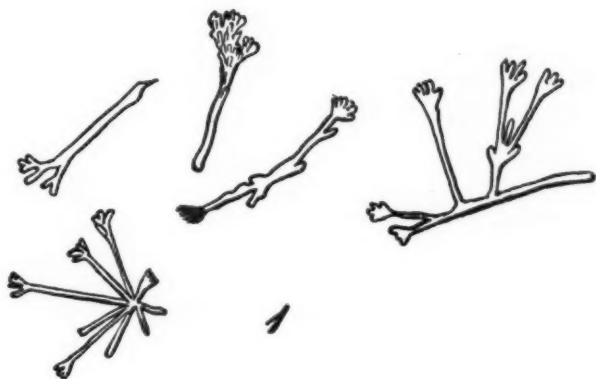
³ The moistening has the disadvantage of rendering the extraction difficult, but has the great advantage of keeping the powder together.

⁴ Prepared by shaking together chloroform and spirit of ammonia.

⁵ *Schweiz. Apothek. Zeit.*, 1921, 59, 36.

the previously⁶ described crystals are seen. They can best be observed if the evaporation takes place first and they are then taken up with a drop of water. Even with 1 mgm. of the powder the crystals of the free bases will appear.

Cortex Quebracho. Treat with ammoniacal-chloroform on a slide. After the chloroform evaporates, numerous crystals are seen, shaped like little rods, which polarize faintly. As to what indication this may be is open to question. Canadin-sulphuric acid produces at the edge here and there a violet tint. Heating with a 1 per cent. solution of perchloric acid produces a brownish-red.



1. Crystals of Cinchona Alkaloid.

Folium Belladonnae. Treat with ammoniacal-chloroform in a test tube. Dissolve the residue in 1 cc. of diluted sulphuric acid, add the same quantity of concentrated sulphuric acid and heat. The liquid will develop the "Blütenduft"⁷ or "blossom odor," which is produced by the same treatment of atropin and hyoscyamin. Sensitiveness about 0.05 gm.⁸

⁶ They did not appear if extracts had been made beforehand from the rind with hydrochloric acid.

⁷ The reaction for the "blossom odor" from atropine and hyoscyamine is usually carried out by Guliemo's method. The alkaloid is heated with concentrated sulphuric acid and water added, but the method mentioned above is preferable, inasmuch as it is less dangerous.

⁸ If we proceed with *Folium belladonnae* as described for *Folium coca*, adding bromine-potassium bromide solution to concentrated hydrochloric acid, crystals resembling those described by R. Eder (*Schweiz. Apothek. Zeit.*, 1916, 54, 657), for atropin appear. Neither here nor with the other solanaceous drugs, as stated in what follows, do they appear with certainty, yet the reaction has value.

Folium Cocæ. Treat 0.5 gm. of the powder with ammoniacal-chloroform in a test tube. The residue after evaporation is taken up with 2 cc. N/100 hydrochloric acid; filtered and concentrated to about 0.05 cc. The concentrated liquid is mixed with a few small crystals of potassium-diamino-tetranitrito-cobalt. Bunches of needles of the previously described kind are formed,⁹ especially at the edge, but which must not be confounded with crystals of the reagent.

Folium Hyoscyami. The same treatment as in the case of *Folium Belladonnæ.* The "blossom odor" was very distinctly perceptible when only 0.2 gm. of the powder was used.

Folium Jaborandi. Treat 0.5 gm. of powder with ammoniacal-chloroform in a test tube. Take up the residue with 1 cc. of water, filter, add to the filtrate a small grain of potassium chromate and 1 cc. of chloroform and shake thoroughly with 1 cc. of a 3 per cent. solution of hydrogen dioxide. The chloroform becomes blue (reaction of *Helets*).



2. Crystals from Opium with Ammoniacal Chloroform.

Folium Stramonii. Apply the treatment as for *Folium Belladonnæ.* The "blossom odor" was perceptible with 0.2 gm. of drug.

Opium. For the chemical characterization of opium a process already described consists in separating the morphine with ammonia as sphero-crystals and the identification of these by the reaction with formalin-sulphuric acid. Other methods of procedure are the following:

1. Treat with ammoniacal-chloroform on a slide. Numerous crystals of different varieties appear (diagram 2), prisms predominating, but also sphero-crystals and stramonies (thorn-apples). It can be proved that of these crystals some indicate morphine and some narcotine:

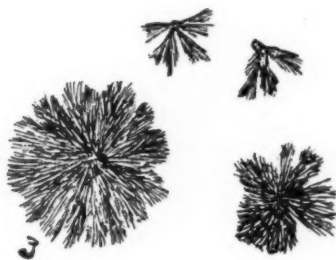
⁹ Schweiz. Apothek. Zeit., 1923, 61, 10.

(a) the crystal zone gives a violet, with formalin-sulphuric acid.
(b) When heated with arsenic acid-sulphuric acid, a red tint appears.

2. Very small portions of opium become surrounded with a red zone when heated with arsenic-sulphuric acid.

3. Triturate opium with a little water, to a drop of the solution add a drop of potassium-mercuric-bromide solution.¹⁰ A precipitate will be formed, which becomes after a short while an aggregate of various forms (see diagram 3), (druses, fans, bouquets), and which consist, mostly if not exclusively, of morphine-mercuric bromide.

4. Finally, as is well known, meconic acid can be easily determined with ferric salts. The best method of procedure is to triturate opium with a little water and add a small crystal of ferric ammonium sulphate, all around which a reddish zone appears.



3. Crystals from Opium with Potassium Mercuric Bromide.

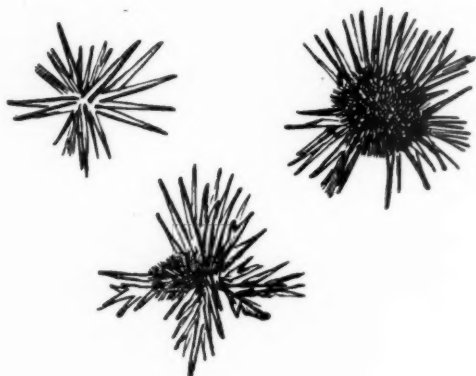
As in opium, morphine can be identified in *Fruct. Papaveris immaturi*: Treat these first with ammoniacal-chloroform in the test tube, take up the residue in N/10 hydrochloric acid, and concentrate it to 1 to 2 drops. If potassium mercuric bromide is added the above-described crystals will be produced on the application of 0.1 gm. of *Fruct. Papaveris*. The formation of a precipitate occurred also when much less material was used but it remained amorphous. If the solution obtained with hydrochloric acid is evaporated to dryness and formalin-sulphuric acid added to the residue, a violet tint will appear even with 0.05 gm. of the material.

¹⁰ A solution of 2.5 gms. of mercuric chloride and 5 gms. of potassium-bromide in 50 cc. of water.

Radix Belladonnæ. Proceed as with *Folium Belladonnæ*: the "blossom odor" (without the purple tint) was observed with 0.05 gm. of the powder.

Radix Calumbæ. Treat with ammoniacal-chloroform in a test tube. The residue is taken up with 2 cc. of N/10 hydrochloric acid and the filtrate concentrated. In this way a yellow fluid is obtained, which gives the following reactions:

1. On the addition of sodium nitrate there is produced a yellow precipitate, which is soon converted into little druses.



4

4. Crystals Originating from *Radix Calumbæ* with Diamino-Tetranitrito-Cobalt-Potassium.

2. With potassium iodide an amorphous yellow precipitate appears.

3. With iodic acid a yellow precipitate is formed, which is gradually converted into small druse-like aggregates.

4. Diamino-tetranitrito-cobalt potassium gives manifold, ramified yellow bunches of needles (see diagram 4).

Radix Ipecacuanhæ. 1. Treat with ammoniacal-chloroform on a slide. Add molybdic-sulphuric acid and a drop of concentrated hydrochloric acid. Around the powder, or near to it, green zones appear, at the side of which or after which purple-colored ones may arise. It was observed that after the disappearance of the green zones, smaller parts at the most extreme places assume a violet tint.

If a little of the powder is mixed on a slide with diluted hydrochloric acid and several small grains of chloride of lime sprinkled in these become surrounded with an orange red zone.

Rhizoma Gelsemii. 1. Treat with ammoniacal-chloroform in a test tube. The residue is taken up with 2 cc. of N/10 of hydrochloric acid. Evaporate to dryness (during the evaporation needles form). The residue, taken up with sulphuric acid, gives violet stripes with ammonium vanadate. 2. If an extract is made with ammoniacal alcohol, greenish fluorescence, due to beta-methylæsculetin, is perceptible even in an 1:1000 extract.

Rhizoma Hydrastidis. 1. Treat with ammoniacal-chloroform on a slide. After the evaporation of the chloroform, at the edge of the cover-glass appear numerous yellow crystals (little rods) of berberine. If vanadic-sulphuric acid now be added, a red-violet zone develops around the powder (hydrastine). 2. If an extract of the powder is made with ammoniacal-chloroform and the filtrate allowed to fall by drops into a dish, containing vanadic-sulphuric acid, a violet coloration (hydrastine) appears gradually at the edge, but in the middle a black-brown one (berberine).

3. Heat the powder on the slide with a little water and, after cooling, add a drop of nitric acid. An abundance of needles of berberine nitrate will appear, frequently in bunches.

4. The aqueous extract, acidulated with hydrochloric acid, becomes red by the addition of a small grain of chloride of lime.

5. Heat 0.1 gm. of the powder with 2 cc. of diluted sulphuric acid, mix the filtrate at about 60 degrees C. with barium permanganate, until a violet tint appears, and remove this by alcohol. Filter, add a drop of iodic-acid solution and allow a drop of the solution to evaporate on the slide. Bright yellow spherocrystals appear, probably hydrastinine-iodate.

Rhizoma Veratri. Treat with ammoniacal-chloroform in a test tube. Heat the residue with concentrated sulphuric acid and a red coloration will appear. This results with only 0.05 gm. of the material.

Secale cornutum. (a) Test of the alkaloids (ergotoxine, ergotimine, ergotamine). Treat with ammoniacal-chloroform in a test tube. Dissolve in concentrated sulphuric acid, the residue remaining after evaporation of the chloroform, cover with a layer of acetic ether and allow a drop of a 3 per cent. solution of hydrogen dioxid

to flow into it. At the boundary zone a blue ring appears. (*Walter's* reaction.) This is noticeable with only 0.1 gm. of ergot.

(b) Test of the sclererythrin. Extract with ether, to which a drop of diluted sulphuric acid has been added. Shake the filtrate with a watery solution of sodium acid carbonate. The watery layer becomes violet-blue (reaction of *Hoffmann-Hilger*). This appears with only 0.05 gm. of ergot.

Semen Calabar. Treat with ammoniacal-chloroform in a test tube. The residue obtained after evaporation is heated with a 1 per cent. solution of iodic acid. A reddish-violet appears that cannot be shaken out with chloroform, that is to say, it does not originate from iodine. It appears very strongly with only 0.05 gm. of the drug.

Semen Colæ. Instead of a test for caffein, that is mentioned by Ph. Helv. IV, which is uncertain, the following is recommended: Treat with ammoniacal-chloroform on a slide. Numerous crystals of caffein are obtained at the edge. These can be identified better than with gold chloride with mercuric chloride.¹¹

Semen Colchici. Treat with ammoniacal-chloroform on a slide. If hydrochloric acid (1.19) is added, after the evaporation of the chloroform, a strong yellow tint (colchicine) will appear.

Semen Sabadilla. Treat with ammoniacal-chloroform on a slide. After the evaporation of the chloroform heat with concentrated sulphuric acid. The edge zone becomes red to violet. Notably drops of this coloration appear.

Semen Stramonii. Treat with ammoniacal-chloroform in a test tube, take up the residue with diluted sulphuric acid and concentrate the filtrate by heating in a test tube. The "blossom odor" is distinct even with 0.05 gm. of the material.

Semen Strychni. Treat with ammoniacal-chloroform on a slide. If some vanadic-sulphuric acid is added after the evaporation of the chloroform, the edge zone becomes violet (strychnine). If another portion is treated with concentrated nitric acid, orange-red islands appear on the edge (brucine).

¹¹ For illustration of the Bunches of needles, see "L. Rosenthaler, Qualitative Pharmaceutical Analysis," 87.

ABSTRACTED AND REPRINTED ARTICLES

INDUSTRIAL CHANGES DUE TO CHEMISTRY†

By Edward R. Weidlein*

THE UNITED STATES heads the countries of the world in material property and in the production of wealth. Especially since the World War there has been a relatively smooth flow in immense volume of goods for the satisfaction of innumerable wants.

The causes of this prosperity have been given much discussion. All students of the subject agree, however, that the production of wealth has increased more rapidly than the population. There is, therefore, more wealth per inhabitant than before. As a reason for this increase is advanced the view that more machinery is being used today in production; human labor is being supplanted by mechanical devices. While it is certainly true that more machinery and more power are at the service of the American people than ever before, the essentially fundamental part played by scientific research in enhancing national wealth and welfare cannot be overlooked. Scientific investigation on behalf of manufacturing (industrial research) is the guiding hand of the modern manager. It has brought him his methods as well as much of his mechanical equipment.

Technology and science have their meeting-point in industrial research, wherein the languages of chemistry, physics and biology, the industrially basic sciences, are translated to the manufacturing world.¹ The essence of industrial research is invention; the most important object, the application to industry of scientific fact.

Technology has a vast domain, including all the forms of industry, physical or chemical (embracing biochemical) or a combination of both. The manufacture of leather or the production of pig iron is a chemical operation, while the making of a shoe or the rolling of a

†Reprinted from *The Annals of the American Academy of Political and Social Science*, Philadelphia, September, 1928. Publication No. 2154.

*Director, Mellon Institute of Industrial Research, Pittsburgh, Pa.; President, American Institute of Chemical Engineers.

¹The writer has dealt with the technologic position of science from other angles in *The Pittsburgh Record*, 2 (1928), 275.

rail is a physical process. In most technologic branches, however, the products are the results of chemical action, and then, too, the practical success of the operations is dependent upon the choice of materials used in the construction of the plant as well as upon its correct arrangement from an engineering standpoint. The industrial chemistry of today has been developed along physical or engineering lines, and hence industrial research is largely physicochemical in nature. Chemical engineering, the directional force of much of technology, is in inward nature applied physical chemistry.

Chemistry, the eldest of the experimental sciences, made research, but it remained for economics to show the need for and value of industrial research. As early as 1890 the opinion was expressed in England and on the continent by chemists who sensed the trend of developments in their science, that the greatest advance in future years would take place in America. Although European countries stood in the forefront at that time, it was felt that conditions were such in America that we were destined to take the lead in a not distant date in both industrial and scientific achievements. This prophecy has to a large extent been fulfilled. For many years the German chemical manufacturer was far in advance of those of all other nations in recognizing the utility of industrial research; but during the past decade American technologists have assumed leadership in employing highly trained chemists and other scientists in original researches with a view to new discoveries or to useful improvements. The United States now has the largest chemical industry in the world, with a production valued at more than \$2,275,000,000, and this position has been attained through co-operation between aggressive capital and creative science (see Table I).

Among the topics of technology that have been especially enriched through research is metallurgy. In early times metallurgy was chemistry, as now metallurgy has become chemistry. Fuels, particularly coke, manufactured gas and petroleum, and ceramics, including glass, clay products, refractories and cements, also relate to chemical substances that have been given extended research by specialists, through which have come great improvements in the quality and cheapness of the old products as well as many new products. But the inorganic and organic chemical manufactures, food production, textile technology, and the leather and paper industries have been even more notably benefited by chemical research.

TABLE I.—TOTAL CHEMICAL PRODUCTION, IMPORTS, AND EXPORTS IN 1899, 1914, AND 1927*
(IN MILLIONS OF DOLLARS)

Chemicals	Production			Exports			Imports		
	1899	1914	1925	1899	1913	1927	1899	1913	1927
Naval stores, paints and varnishes	90	168	528	12	34	56	7	12	30
Rosin and turpentine	20	21	46	10	26	34	...	...	...
Pigments, paints, varnishes	70	147	482	2	8	21	1	2	4
Coal-tar products	1	13	112	...	0.1	17	5	15	24
Dyes and other finished .....	...	...	62	...	...	5.5	4.5	10	6.5
Crude drugs, essential oils, waxes	59	114	307	2	4	7	8.5	14	36
Essential oils	0.7	2	6	0.2	0.7	2	2	5	6
Explosives, pyroxylin, matches	25	63	132	0.5	4	5	0.5	2	5
Explosives	17	41	70	0.2	3	2.5	...	0.5	0.1
Matches	6	13	24	0.1	0.1	0.1	0.1	0.7	2.2
Fertilizers	53	176	235	7	12	18	6	43	63
Industrial chemicals	55	177	491	8	16	50	20	31	29
Medicinal and toilet preparations	89	167	473	3	9	29	1	7	12
Prepared medicines†	59	102	175	2.7	7	18	0.9	5	5
Toilet preparations	7	17	150	0.3	2	9	0.5	2	7
Total	372	878	2278	32.5	79.1	182	48	124	199

*Sources: production, Bureau of the Census; exports and imports, Commerce and Navigations of the United States, Bureau of Foreign and Domestic Commerce; A. H. Swift, *Industrial and Engineering Chemistry*, 20 (1928), 658.

†"Prepared medicines" also includes such compounds as insecticides, fire-extinguishing compounds, deodorants, and similar preparations in 1899 and in 1914, but not in 1925.

In this article an effort will be made to show clearly the high utility of chemistry in industry.² Since it is thought by the writer that chemistry is one of the foundation stones on which national progress rests, the evolution of chemico-industrial research in the United States will first be described, and then an attempt will be made to indicate the changes of economic importance that chemistry has wrought in a number of essential industries.

The Initial Stage of Techno-Chemical Research in America

The first manufactures in colonial America—pot or soap ashes in 1608, glass in 1610 and leather in 1620, all in Virginia—were chemical in nature. But American chemical technology actually had its beginning in the pioneer work of John Winthrop, Jr., who landed in Boston in 1631, at the age of 25. He became interested in the production of alum, copper, glass, iron, potash, salt, saltpeter, tar, and other needed commodities; and he and his uncle, Emanuel Downing, carried out experiments on the preparation of indigo that entitle them to the honor of having conducted the first industrial research within the present borders of the United States. In 1662, Winthrop read a paper on making tar before the Royal Society of London.

The earliest organized effort to encourage scientific investigation on behalf of American industry is reported in the preface of the first volume of the *Transactions of the American Philosophical Society*, published in 1789, in which the aims of the Society were presented. Among these were "making useful discoveries that would . . . promote the interest of the country." What was evidently one of the first contributions to chemistry from this country, bearing the date September 10, 1768, appears in the *Transactions* of this society under the title "An Analysis of the Chalybeate Waters of Bristol in Pennsylvania," by John de Normandie.

In his first annual address, in 1790, President Washington said:

"The advancement of . . . manufactures by all proper means will not, I trust, need recommendation; but I cannot for-

² The writer has discussed other aspects of the national importance of chemical research in *Proceedings of the Institute of Management*, 1928, No. 6. Reprints of this paper will be sent gratis to all interested persons who request them.

bear intimating to you the expediency of giving effectual encouragement as well to the introduction of new and useful inventions from abroad as to the exertions of skill and genius in producing them at home. . . . There is nothing which can better deserve your patronage than the promotion of science."

In subsequent messages to the American people he gave concurrence to the growing sentiment that the substantial support of science would contribute to the security of the nation. It is related that Washington endeavored to induce Chaptal, the distinguished French chemist, to emigrate to this country. But Chaptal, who was zealous in developing French industries, elected to remain at home.

A book that appeared in 1790—John Penington's *Chemical and Economical Essays*—was intended to illustrate "the connection between the theory and practice of chemistry and the application of that science to some of the arts and manufactures of the United States." On the title page Penington placed this quotation: "It is a pity so few chemists are dyers, and so few dyers chemists." This work was the first American effort to popularize chemistry.

In 1792 there was founded in Philadelphia the first chemical society in the world. Its main object was to collect definite information relating to the minerals of the United States. A standing committee of five chemists was charged with the duty of analyzing any mineral which might be submitted to it, provided it was forwarded free of expense, with an account of the locality and situation in which it was found. The analyses were made without charge. In 1799 this society also gathered information relating to the manufacture of niter, acquainted the public with the uses of various minerals, and encouraged the manufacture of pottery. Evidence of the interest which was evinced at this time in ceramics may be found in an oration delivered by Felix Pascalis before the Chemical Society of Philadelphia in 1801. This savant said:

"Encourage and repeat mineralogical experiments on all kinds of alumine. The first who will successfully procure manufactured works of the kind and tolerably good earthen wares will deserve well of his country and be rewarded by the gifts of fortune."

For years about 1800 Adam Seybert, of Philadelphia, was the leader in the domain of mineral chemistry in this country.

In 1799 the American Mineralogical Society solicited the citizens of the United States to communicate on all mineralogical subjects, "but especially on the following: (1) concerning stones suitable for gun flints; (2) concerning native brimstone or sulphur; (3) concerning salt-petre; (4) concerning mines and ores of lead."³ This society, which had its headquarters in New York, did much to foster the serious study of raw materials of mineral technology.

Among the American chemists of this period who became interested in manufacturing processes was James Woodhouse, professor of chemistry in the medical department of the University of Pennsylvania from 1795 to 1809.⁴ He was the first to demonstrate the superiority of anthracite over bituminous coal "for intensity and regularity of heating power." Contemporaneous with Woodhouse were the following chemists: Robert Hare, the inventor of the oxyhydrogen blowpipe (1802), who obtained calcium carbide, phosphorus, graphite and calcium by the aid of electricity, and is to be regarded as the earliest experimenter in electrochemistry; Joseph Cloud, assay master at the Philadelphia Mint, who, in 1807, made an interesting research—perhaps the first in metallurgy in this country—on a native alloy of palladium and gold from Brazil; John Harrison, the first manufacturer of sulfuric acid in this country (1793), who was an ingenious industrialist and made a number of technical innovations in practice; and Gerard Troost, professor of chemistry at the University of Nashville, who founded an alum factory at Cape Sable, Md., in 1814.

The Awakening of Chemical Technology

American chemical technology received developmental stimuli from the embargo of 1806 and the war of 1812. These effects are clearly seen in the general character of the patents issued to chemical inventors. Previous to 1806 these patents related chiefly to the old colonial industries of distilling, salt manufacture, potash making, and the utilization of sperm oil and other fats for soap and candles.⁵ But after 1806, when the importation of foreign goods was restricted, the inventive genius of American chemists began to be diverted into more

³ *Medical Repository*, 2, 114.

⁴ Woodhouse and also Seybert received their chemical instruction from Benjamin Rush, the holder of the first chair of chemistry established in America, at the University of Pennsylvania, in 1769.

⁵ C. A. Browne, *Industrial and Engineering Chemistry*, 14 (1922), 1070.

modern channels. Between 1806 and 1814 there are noted for the first time inventions that relate to subliming sulfur, dyeing silks and calicoes, bleaching, refining camphor, waterproofing leather, making artificial mineral water, and manufacturing sulfuric acid, copper acetate, magnesia, and white and red lead. The year 1806 marks the real awakening of industrial chemistry in the United States. The first Americans to go abroad for chemical training, Benjamin Silliman, John Gorham, and others, were returning from their studies in Europe and contributed their share to the new movement. American publishers began also about this period to print practical treatises upon chemistry—works of native writers such as Thomas Ewell, James Cutbush, Franklin Bache, and John Gorham, and reprints of European authors such as Jane Marcet, Joseph Black, Samuel Parkes, Thomas Thomson, and Fredrick Accum—and for the first time the attention of the public was called forcibly to the national importance of chemical industries.

The importance of chemistry in agriculture was given considerable thought at this time by members of the Philadelphia Society for Promoting Agriculture. Apparently they recognized the possible application of chemical knowledge to the maintenance of soil fertility. In this society's *Memoirs* for 1811 were articles on the employment of gypsum, leached ashes, lime and salt as fertilizers. Two eminent citizens of the young republic, Thomas Jefferson and John Adams, were endorsers of the study of chemistry for useful purposes, especially in producing better crops and foods. Jefferson regarded Silliman's *American Journal of Science* as among "the things of select reading" which he had time to peruse. In a letter to John Gorham of Harvard in 1817 Adams said: "We are all chymists from our cradles. . . . Chymists! pursue your experiments with indefatigable ardour and perseverance." The fathers of our nation were just as practical as the fathers of American chemistry.

The value of chemistry to industry was well known in 1815, when it was pointed out ^a that the science was

"an important aid to the study of mineralogy, pharmacy, electricity, cooking, metallurgy, and in various manufacturing industries, especially glass, leather, soap, paint, glue, starch, etc. In fact, it would be an easy task to continue almost indefinitely the list of arts whose processes, if they admit of explanation at all, must be explained upon the principles of chemical philosophy."

^a *Analectic Magazine*, 6, 145.

A little later Benjamin Silliman⁷ observed that

"the present period is distinguished by wonderful mental activity; it might indeed be denominated as the intellectual age of the world. At no former period has the mind of man been directed at one time to so many and so useful researches."

By 1822 the manufactures of the United States, though depressed immediately after the war with Great Britain, had considerably increased, and were still increasing, under the stimulus given them by the tariff of 1816 and by subsequent laws. About ten years later President Jackson, in reviewing the satisfactory condition of technology, whose works were being extended with unprecedented rapidity, remarked that "science is steadily penetrating the recesses of nature and disclosing her secrets, while the ingenuity of free minds is subjecting the elements to the power of man and making each new conquest auxiliary to his comfort." Shortly before 1850 the occurrence of gold, silver, copper and mercury in New Mexico and California aroused new interest in mining and metallurgy.

Chemistry in Industry, 1820-1860

Industrial research was carried on extensively in the United States from 1820 to 1860. James Cutbush, professor of chemistry at West Point, made a number of valuable contributions to scientific pyrotechnics, but is chiefly remembered for his description, published in 1822, of the production of cyanogen by the action of nitric acid upon charcoal. A prominent industrial chemist, Samuel Guthrie, of Sackett's Harbor, N. Y., discovered chloroform, engaged in the manufacture of fulminating compounds, and devised a commercial process for the rapid conversion of potato starch into sugar (1832). An able metallurgical chemist, W. W. Mather (1804-1859), of Columbus, Ohio, made an elaborate research on the principles involved in the reduction of Mexican silver ores, in 1833. Lewis Feuchtwanger, who was well known to the chemists of this period by his commercial establishment for the manufacture and sale of "rare" chemicals, devised, in 1837, an expeditious method for the manufacture of vinegar and later, in 1872, studied the process of glass-making. Then there was S. L. Dana, of Lowell, Mass., who was, for fifty years, an acknowledged authority on technical chemistry. After the completion

⁷ *American Journal of Science*, 3 (1821), 330.

of his medical studies in 1818, Dana soon devoted himself to manufacturing chemistry, holding the position of chemist to the Merrimack Manufacturing Company, Lowell, Mass., from 1833 to 1868; he invented the "American system" of bleaching in 1838, and also gave research attention to dyeing, fertilizers and lead poisoning. His book entitled *Muck Manual*, intended for farmers, discussed soils and manures.

The following were among the other chemists of this period who busied themselves in the domain of industry and inspired hosts of younger men: St. Julien Ravenel (1819-1882), who made experiments upon converting South Carolina phosphate rocks into commercial fertilizers; J. C. Booth, of Philadelphia, Pa., noted for his work on beet-sugar (1842), the production of gelatin (1842), the nickel ores of Pennsylvania (1856), and illuminating oils (1862), as well as for being the founder of an active firm of chemical consultants; John Dean, of Boston, Mass., who investigated the value of different kinds of prepared vegetable foods in 1844; David Alter, of Freeport, Pa., one of the discoverers of spectroscopy, who began the manufacture of bromine in 1846 and later became a coal-oil technologist; Charles Lennig, an industrialist of Philadelphia, who was the first to manufacture bleaching powder in the United States (1847) and afterwards (1869) introduced the manufacture of hydrochloric acid by modern methods; L. C. Beck, professor of chemistry in Rutgers College, who made valuable observations respecting bleaching and disinfecting compounds and was an authority on breadstuffs (1848); A. C. Twining, a chemical engineer of the fifties, who invented an ice machine; A. A. Hayes, of Brookline, Mass., a student of the Bessemer process (1852); C. M. Wetherill (1825-1871), who conducted researches on illuminating gas in 1854 and on the manufacture of vinegar in 1860, and who was the first chemist of the U. S. Department of Agriculture (1862); Benjamin Silliman, Jr., the author of techno-chemical classics on Pennsylvania petroleum (1855), California petroleum (1865 and 1867), and on the combustion of fuel (1860); E. N. Horsford (1818-1893), a resourceful research chemist, who studied breadmaking and condensed milk manufacture and worked out processes for preparing phosphoric acid (1856), then was active in creating markets for this product; Henry Wurtz, of New York, who played an important part in the development of the manufacture of glycerin in 1858; and J. M. Ordway, of the Massachusetts Institute of Technology, who investigated the

manufacture of sodium hydroxide in 1858 and of sodium silicate from 1861 to 1865.

Several other branches of manufacture were improved by the results of scientific studies that eventuated in patents during this period. The following subjects were among the ones investigated: desulfurization of ores, concentration of sulfuric acid, manufacture of sodium carbonate, preparation of ferrocyanides and wood distillation products (rosin, turpentine, etc.), vegetable color extraction, inorganic colors, mordants, tannin extraction, paint pigments, gun and blasting powders, match compositions, and rubber manufacture. In each instance improvements, some of them outstandingly important, were patented in consequence of these industrial researches, many of which were crudely conducted as compared with the practices of today.

Techno-Chemical Research, 1860-1880

After 1860 American manufactures increased with wonderful rapidity under the encouragement that they received. They also became more and more diffused, making the interest in them more general. With the improvements in machinery and processes that were effected, imports of many articles fell off largely within a few years.

Joseph Wharton, of Philadelphia, deserves special mention in the history of technology in America. After some preliminary experiments, Wharton erected at Bethlehem, Pa., in the year 1860, a spelter works of sixteen Belgian furnaces, which produced over 3,700,000 pounds of zinc in 1862. The product was of excellent quality, and was made so cheaply as to afford a reliable profit and to plant the zinc industry firmly in the United States. Wharton first reduced silicate of zinc to metal on a large scale, successfully applied anthracite to the manufacture of spelter, and used American clays for making zinc retorts.

Many chemists rendered service to the advancement of industry during the two decades, 1860-1880, and it is difficult to designate the most prominent workers. B. F. Craig, of the laboratory of the Army Medical Museum at Washington, D. C., was engaged in the field of explosives and, during the period 1861-1864, made a number of contributions to our knowledge of gunpowder. Frederick Hoffmann, of New York, was an authority on organic colors and medicinal chemicals. C. A. Goessmann (1827-1910), of the Massachusetts Agricultural College, contributed to the manufacture of salt (1863), the

refining of sugar (1864), and the production of beet-sugar (1872). He was the author of 362 papers and reports. F. H. Storer, of Harvard University, made researches on the alloys of copper and zinc in 1864 and on petroleum in 1865.

Charles F. Chandler, of Columbia University, was always productive in research. His early studies of technical importance were those on water for locomotives (1865), the water supply of New York (1868 and 1870), the purification of illuminating gas (1870), kerosene (1871), and the manufacture of condensed milk (1871). Another chemist who was called upon by the gas industry was Henry Wurtz, who made improvements in the methods of purifying water-gas (1867) and, jointly with Silliman (1869), elucidated the processes of manufacture.

The researches of S. F. Peckham on asphalt and petroleum were carried on from 1867 to 1874. W. H. Chandler, who, with C. F. Chandler, edited the *American Chemist*, contributed to the purification of zinc containing iron (1869) and to the refining of iron (1870). J. B. Britton, chemist to the "Iron Masters' Laboratory," performed a great amount of technical work. S. Dana Hayes, State assayer of Massachusetts, studied the destructive distillation of naphtha in 1871 and was recognized as an authority on petroleum technology. Isidor Walz, of New York, was a textile expert. C. U. Shepard, Jr., of Charleston, N. C., an authority on fertilizers, investigated the effects of sulfur dioxide on vegetation in 1872. Henry Morton, of Stevens Institute, had occasion to conduct a series of researches on petroleum (1872-1874). J. P. Kimball, of Lehigh University, engaged in work in ferrous metallurgy and found uses for emery in the iron industry (1873). R. W. Raymond investigated the calorific value of lignites in 1873. J. F. Babcock, of Boston, Mass., carried out researches which established him as an expert on wood preservation. T. M. Drown, professor of chemistry at Lafayette College, was the author of important papers on the blast furnace, the puddling and Bessemer processes, and the conditions of carbon in gray and white pig iron. H. M. Pierce was most active in the promotion of the interests of the wood-distillation industry. C. E. Avery, of Boston, Mass., laid the foundation for the manufacture of lactic acid. Charles and Nelson Goodyear and A. G. Day are known for their inventions in connection with rubber. R. C. Kedzie (1823-1902) originated the Michigan beet-sugar industry and added to the knowledge of fertilizers.

TABLE II.—EARLY AMERICAN CHEMICAL INDUSTRIES

Manufacture	First Manufacturer	Year	First Important Improvement	By Whom	Year
Sulfuric acid	John Harrison, Philadelphia, Pa.	1793	Platinum still for concentrating	John Harrison	1814
Gunpowder	E. I. du Pont de Nemours, Wilmington, Del.	1802	Manufacture of potassium nitrate from sodium nitrate	DuPont Company	1868
White lead	S. Wetherill & Son, Philadelphia, Pa.	1804	The use of cheaper material from Mo. and Ill.	—	1850
Pharmaceutical chemicals	Rosengarten & Sons, Philadelphia, Pa.	1823	Production of ether and quinine, 1823; morphine, 1832; strychnine, 1834	Rosengarten & Sons	—
Varnish	P. B. Smith, New York, N. Y.	1828	Improvement of quality to create a foreign market	P. B. Smith	1836
Wood distillation	James Ward, North Adams, Mass.	1830	Manufacture of acetate of lime and wood alcohol	J. A. Emmons and A. S. Saxon	1867
Nitric acid	Carter and Scattergood, Philadelphia, Pa.	1834	Distillation apparatus	Edward Hart	1898
Hydrochloric acid	Carter and Scattergood	1834	Manufacture by modern methods	Charles Lennig	1869
Chlorine	Charles Lennig, Bridesburg, Pa. (Bleaching powder)	1847	Commercial process for the electrolytic decomposition of sodium chloride	E. A. LeSueur	1893

Techno-Chemical Research During the Last Half-Century

Sufficient has been presented to show that American chemists have, from the inception of the republic, been constantly engaged, to a greater or less degree, in original investigations of the problems of manufacturing. Time will not permit the recounting of all the valuable contributions which have been made by the chemical profession during the most modern period of our industrial history, from about 1880 to the present time. It will be necessary to limit our consideration to some of the most notable achievements in a few of the important technologic fields.*

Herbert Spencer once remarked, "It is only by perpetual aspiration after what has been hitherto beyond our reach that advance is made." For many years American scientists, and especially chemists, aspired to the extension and organization of the application of research method in industry. This great ambition, largely fostered during the past decade by such agencies as the American Chemical Society, the National Research Council, and our engineering societies of national scope, received an encouraging impetus about twenty years ago, when Robert Kennedy Duncan put into operation his Industrial Fellowship System, a practical procedure of linking the university laboratory to industry, for attacking the latter's problems, which soon led to successful co-operation and productive effort. These beneficial results promptly stimulated workers in and supporters of existent industrial research establishments; they also showed clearly, to university science teachers, the importance and utility of applied research, and the coming need for capable investigators. During and since the World War the development of industrial research has been remarkably rapid, in the many branches of manufacture that have been or expect to be improved by scientific investigation, as well as in the research training schools. From what has been said, however, it is plain that all progress in industrial chemistry is made by evolution

* Other industries have been given attention elsewhere by the writer. In an article published in *Chemical and Metallurgical Engineering* in 1927 (34, No. 4), he has described research feats in the aluminum, carbon products, electrical, explosives, glass, hydrocarbon products, lead, nickel, paint, photographic, rubber, and synthetic resin industries. He has also discussed lacquer, plastic, rubber, and solvent research in *The Pittsburgh Record*, 2 (1928), 270-5. Reprints of these papers are available for gratuitous distribution.

and not by revolution. In the past we have had various successive periods of human activity that have been characterized by the use of stone, bronze, iron, etc. A very appropriate term to apply to the period in which we are now living, and which began with the creation of modern chemistry in 1774, would be "The Chemical Age."

Notable Research Accomplishments in Metallurgy

Chemically controlled industry in the United States is relatively modern. In illustration of this fact we have the record of the attitude of various American industries toward chemistry less than seventy years ago. As late as 1860 J. C. Booth, a chemist mentioned previously, endeavored to induce the iron masters of eastern Pennsylvania to contribute jointly the small annual sum of \$1200 for controlling the work of their furnaces by chemical analyses of the ores. It is related that he was completely unsuccessful in his efforts. There has never been any royal road in industrial research.

Later on, however, iron and steel industrialists began to take an interest in chemistry, largely because Andrew Carnegie, the great iron master and a great business man, found that little furnaces could be run by rule-of-thumb and guess, but not such large furnaces as he decided to equip and operate in Pittsburgh. He employed a chemist to assist the manager of his works, and straightway "Lucy Furnace," an undertaking of magnitude in those days, "became the most profitable branch of our business, because we had almost the entire monopoly of scientific management. It was years after we had taken chemistry to guide us that it was said by the proprietors of some other furnaces that they could not afford to employ a chemist. Had they known the truth then, they would have known that they could not afford to be without one."

The technically important contributions of chemistry to the iron and steel industries began with the introduction of the great pneumatic process of steel-making. The Bessemer process and the Siemens-Martin open-hearth process produced a far-reaching change in the iron industry that afforded the chemist his first real opportunity. Prior to the days of steel, iron-making was largely an empirical art, and no manufacturer considered the estimation or control of the impurities which generally accompany the metallurgy of iron to be a vitally important matter. Of course, it was known through the oper-

ation of the puddling and crucible processes that certain elements imparted hardness and toughness, but the very important quantitative rôles in the metallurgy of iron played by carbon, manganese, sulfur, phosphorus and silicon were not understood. Original chemical researches into the methods for determining and controlling these so-called impurities forced the essentiality of chemistry upon ferrous metallurgists. Indeed, the iron blast-furnace is but the chemist's crucible on a gigantic scale, operated on chemical principles; and the application of chemistry to iron smelting has effected such wonderful transformations that today the chemist occupies the foreground in directing the operations in the industry. Not only has inorganic chemistry in its analytical and physical branches played a highly important part in the steel industry, but organic chemistry has also entered the field in the by-product coking of coal. Thermochemistry, electrochemistry, and metallography are the divisions of physical chemistry which have been most active in promoting the scientific development of the metallurgy of steel. Ceramics has also been of essential aid in providing information respecting refractories.

It is difficult to recall a more far-reaching invention than that of the dry air-blast for the manufacture of iron, devised by James Gayley, a metallurgical chemist. This discovery effected a reduction of from \$0.50 to \$1 per ton in the cost of producing pig iron, besides making it possible for the ironmaster to produce, in all weathers, a metal of uniform quality. The dry air-blast was developed by Gayley between 1885 and 1904 at the Edgar Thomson and Isabella furnaces in Pittsburgh.

Other Achievements in Metallurgy

The growth of the manufacture and uses of alloy steels has been phenomenal. These special steels contain, besides iron and carbon, the element or elements capable of altering the physical characteristics of the iron or of increasing or otherwise influencing the effect of the carbon present. High-speed tool steels contain large percentages of tungsten, chromium and vanadium. One of the earliest alloy steels, Hadfield's manganese steel, contained from 12 to 14 per cent. manganese. Later nickel steels of the "Invar" type containing from 35 to 40 per cent. nickel were developed and today the exploitation of high-chromium steels of the "rustless" or "stainless" type is being

carried on with energy. This last type of steel contains chromium from 8 to 60 per cent., either alone or associated with other alloying elements, such as nickel, silicon, or copper.

Alloy steels have been responsible for important developments in several industries. The efficiency of electrical equipment is based on the use of high-silicon steel, a steel carrying about 4 or 5 per cent. of silicon. Besides the use of silicon steel in motors, generators, transformers, etc., all magnetic apparatus is dependent upon steel carrying either tungsten, cobalt or chromium. Resistance heating elements are also dependent upon high percentage alloys of chromium and nickel, which have made possible the extended use of electrical heating.

Alloy steels have played an important part in the generation of power. High-speed turbines with high chrome blades have been developed, and, with the advent of steels possessing great mechanical strength at high temperatures, the problem of the internal combustion turbine will be solved. In the generation of steam power and in superheating steam, boiler material is needed that is similar to the requirements of the oil-cracking and synthetic nitrogen industries, where nickel and especially vanadium are useful. The modern tendency in locomotive construction is toward higher and higher pressures, and boiler plates, stay bolts and rivets will be subjected to higher stresses. Vanadium steels are being developed especially for this work. Nickel has also been investigated for the purpose.

Another engineering achievement which seems to promise revolutionary results in transportation problems is the application of roller bearings to railroad work. This would not be possible without the use of appropriate alloy steels.⁹

The metallurgical industries have to do with fifty other well-known metals, in addition to iron, as well as with over 1600 alloys. Metallurgy is largely chemical in character—smelting, refining, electroplating, alloying, and heat treatment involve various phases of chemistry—and in all metallurgical advances the chemist has done, is doing, and will do most of the work. This fact is conceded even by the 25 per cent. of all metallurgists who did not start as chemist (as did three-fourths of the metallurgical profession) before they

⁹ Information received from B. D. Saklatwalla, Vanadium Corporation of America, Bridgeville, Pa.

entered the field of metallurgy. The Cottrell process for smoke precipitation is a well-known physico-chemical research contribution to applied metallurgy.

The corrosion problem is outstanding in the use of metals. It has been calculated, for example, that the annual wastage of iron and steel through corrosion totals over three billion dollars. Sufficient progress has been made in metallurgical research, however, to enable the visualization of non-rusting metals. At present chromium seems to hold out the most promise for many purposes.

The chemist has completely revolutionized the art of shaping and finishing metals by grinding. Through research, he discovered artificial abrasives (carborundum, alundum, aloxite, etc.) and created grinding wheels and other shapes. In this way, too, he helped most materially in founding the electrochemical industry, which he has since built up.

The first electrochemical enterprise to be established at Niagara Falls was that of the Aluminum Company of America for the manufacture of aluminum according to the process of a chemist, Charles M. Hall. The electrochemical industry also produces calcium carbide, silicon, cyanamide, graphite, phosphorus, nitric acid, refined lead, ferrosilicon, ferrochromium, other ferro-alloys, sodium, chlorine, and other essential materials of modern life. All these manufactures have been evolved from chemical discoveries. Chlorine is the greatest contribution of the chemist to sanitation. Fully three-fourths of the water supplied to cities in the United States for household use is first chlorine-treated. Nitrogen, oxygen, hydrogen, helium, acetylene, and carbon dioxide are other industrial gases whose production and applications have been worked out by the chemist.

Another very important manufacture that has been due mostly to chemistry is the by-product coke industry. Modern civilization rests largely upon coal and iron, which, in turn, are linked by coke. In making coke other materials, termed by-products, are had, from which modern chemistry has developed thousands of indispensable chemicals, fertilizers, explosives, disinfectants, perfumes, roofings, wood preservatives, medicines, and practically all the dyes used in the textile industry.

The Chemist in the Portland Cement Industry

In the field of ceramic building materials, the chemist's most notable contributions have been made to the Portland cement industry. It was he who surmounted the difficulties encountered in producing a uniform product of good quality. He determined the essential constituents, their necessary proportions, the influence of grinding and mixing of the raw materials, and the proper burning temperature. He then was active in developing mechanical equipment of efficiency and aided valuably in establishing the superiority of American-made Portland cement. The rotary kiln, developed technically by the Atlas Portland Cement Company, is looked upon generally as the leading American mechanical innovation. In 1895, the industry of the United States was producing less than one-third of the Portland cement used in this country. By 1900, however, the American producers began to be rewarded for their support of chemical research. The domestic production of Portland cement was over eight million barrels during this year—eight times greater than five years before—and since then the American industry has grown enormously to meet the requirements of the so-called "concrete age." The annual production capacity of our plants is at least 200 million barrels of Portland cement.

Science is making the road a product far beyond the ability of the old-time road-worker. Highly complex paving mixers leave behind a trail of molded rock that enables the motorist to get the most out of his investment in locomotion. The cost of traveling over the jolting highways of two centuries ago was much higher than the cost of journeying over the best roads of today. Three cents a mile was the average cost in driving an ordinary vehicle. Tax authorities tell us that the cost per mile of smooth motor travel at present, considering gasoline and automobile registration taxes, is but 1.6 cents, and this in money with a lower purchasing power. Until a few years ago pavement building was such a slow process that it seemed futile ever to hope that hard roads would thread every county and State. In 1910 a month was required to construct a single mile of concrete. Today a gigantic mixer may leave a 1500-foot strip of concrete behind it every eight or ten hours.

Industrial Water Problems

It has cost the industries large sums to learn a little of the importance of water. One manufacturer found out that he had been wasting more than \$100,000 in a single year on raw materials, purchased without regard to moisture content, whereas this sum might have been saved had he realized the importance of the accurate control of moisture.

Large annual dividends are being earned on the investment in research upon boiler-feed waters. One railway finds that a water-treating plant pays for itself each year. Another great system must use a wide variety of water, each requiring special study and treatment. Before a chemist was employed, one run of 563 miles required three or four engines. This run is now made with a single locomotive. In another district the boiler tubes of switch engines had an average lifetime of seven months. Research is responsible for extending this time to thirty-one months. The life of boiler tubes in the more than 1600 locomotives of this railway system has been lengthened from two to four times. With replacement costs about \$1200 per set of tubes, this result indicates a large return on the research and development work. The life of fire boxes, an item approaching \$1700 per engine for renewal, has been multiplied by three.¹⁰

Chemistry and Refrigeration

There is so much engineering involved in some industrial operations and plants that the part played by chemistry in their development is not generally apparent to laymen. Refrigeration is a case in point. History reveals that the vacuum system of ice-making was discovered by a chemist, William Cullen, in 1755; that Joseph Priestley, another chemist, ascertained the extreme solubility of ammonia in water, thereby supplying the basis for the water-ammonia absorption machines; that chemical research has evolved the solid adsorbent and absorbent; and that chemistry has developed the various refrigerants that have been used (ammonia, sulfur dioxide, carbon dioxide, ethyl ether, methyl ether, ethyl chloride, methyl chloride, and the hydrocarbons). Chemistry has also solved the complicated lubrication problems that have arisen in the refrigeration field during the past five or six decades, and has investigated and minimized

¹⁰ *Industrial and Engineering Chemistry*, 15 (1923), 223.

corrosion by calcium chloride used as a "brine" or for transferring refrigeration. In this field, as in most of the other mechanical equipment fields, the research chemist has devised protective coatings or paints for metal surfaces, and has effected improvements in the quality of the materials used in the construction of machinery of all types.

Science entered the food-packing industry somewhat late in its history, at a critical period in its development, when mechanical refrigeration was taking the place of natural ice refrigeration, and mechanical devices the place of hand labor. Thus, the chemist, physicist, and bacteriologist could work hand in hand with the construction engineer and mechanical engineer. During the last decade of the nineteenth century many of the meat packers thought that their goal had been reached, that all by-products had been saved, and that all operations were carried out in the best manner possible. This idea was a natural one, because of the enormous development of the industry from its simple foundations. It should be borne in mind that packing-house technology as developed in America is distinctly a new industry and received no guidance from the Old World. Nearly all other industries have been transplantations. The advent of science brought in improved practices in every direction: the industry underwent a new development, which is still in progress; indeed, at present it may be said to be at its height. Perhaps the greatest contribution of science may be summarized in the statement that a certain reasonableness has been introduced into all operations and the bad practices, fads, prejudices and notions which formerly grew up and had equal standing with very excellent and logical methods have been nearly all eliminated.¹¹ Science has now permeated every branch of the food-packing business.

Chemical Research in the Electrical Industries and in Aviation

Chemistry has been of vital importance in perfecting and manufacturing incandescent lamps and also radio tubes. The chemist has developed filaments, methods for removing gases from lamps, and suitable glass; he has also served by making pure, highly conducting copper, and by preparing needed alloys, porcelains, insulation and dielectrics. The well-known Moore tube and the neon glow lamp are based upon chemical principles.

¹¹ Statement of W. D. Richardson, Swift & Co., Chicago, Ill. (*See Chemistry in Industry*, New York, 1, 264.)

Great economies have resulted from metallurgical research in the telephone industry.¹² Two examples will be given here.

Originally, the lead from which cable sheaths are made was given a 3 per cent. admixture of tin to obtain the necessary mechanical properties in the alloy. About twenty years ago the price of tin advanced, while the increase in the quantity required for new telephone cable construction became so large that research was called upon to provide a substitute. As a result new sheaths contain one per cent. of antimony, and within ten years the new formula earned a saving approximating \$6,000,000.

Another important metallurgical result was an improved contact metal used in the millions of relays and tiny switches required in telephone plants and central stations. In seven years this new metal effected savings that totaled about \$13,000,000.¹³

A few years ago the X-ray tube was an erratic apparatus not in very general use. The research laboratory of the General Electric Company realized that there was a possibility of utilizing pure electronic emission from a hot filament to produce controllable X-rays in a perfect vacuum. This laboratory conducted extensive research upon such devices as then existed, and as a result the tungsten target took the place of platinum in the standard gas tube of that day. Research had also to be applied before the laboratory learned positively that available electrons already existed and there was a possibility of controlling them, as, for example, focusing them on a target. The research has been continued, until today practically all the X-ray tubes of the country are made by the company in accordance with the discoveries of the man whose name the tubes bear. The Coolidge tube is also used abroad almost to the exclusion of other types. These remarkable results have been achieved through very careful, accurate and often-discouraging studies of electric phenomena in high vacua, with very pure materials. The perfection of the tube is the nucleus of an annual business, including accessories and generating apparatus used in X-ray work, of from five to ten million dollars a year. The benefit cannot be measured wholly in monetary return, however, for everyone can perceive the humanitarian results of this research.¹⁴

¹² On other achievements of research on communication, see *Industrial and Engineering Chemistry*, 18 (1926), 661.

¹³ *Ibid.*, 15 (1923), 993.

¹⁴ *Ibid.*, 14 (1922), 180.

In aviation the chemist first supplied hydrogen and then helium for lighter-than-air craft. He later solved the problem of finding satisfactory leakproof coverings for gas bags. He has not, however, restricted his efforts to the treatment of fabrics for dirigibles. He has also developed coatings for the cloth coverings of airplane wings and fuselages, antiknock engine fuels, light alloys of aluminum, engine valve alloys, luminous paints, and adhesives (casein and blood-albumin glues).

Chemical Contributions to Agriculture

The manufacture of fertilizers, an industry of vast proportions, is very closely associated with chemistry and largely dependent on the science for its very existence. Having demonstrated the necessity of the industry by his researches on the composition of soils and plants, the chemist has established the manufacture of superphosphate; he has shown how to convert various minerals and many waste products into plant food constituents, how to change the nitrogen of the air into forms usable as plant nutrients, and how to make sulfate of ammonia from nitrogenous minerals (*e. g.*, coal); and also he has found the formulas and blends of fertilizing substances best suited for different soils and crops.

The production of fertilizers is the largest heavy chemical industry in America. Within several years the output of commercial fertilizers will probably reach 15,000,000 tons, in which there will be introduced 315,000 tons of nitrogen, about five-sixths of which will be derived from inorganic sources by the chemist's methods.

The growth of the insecticide industry has been enormous. Its development has come from scientific research conducted jointly by chemists and agricultural specialists; it has been stimulated by the realization of the enormous losses in property and life caused by the depredation of insect pests.

It has been estimated that the annual losses in farm crops of the United States, caused by insects, total about \$1,105,000,000. The losses to forest products and products in storage as well as by insect-borne diseases of man and direct or indirect damage to domestic animals are said to be much less in amount, but nevertheless the figure (\$450,000,000) is impressive. It has been calculated that if a pair of insects destructive to plants should increase for three years without hindrance there would be around 6,000,000 of the pests in existence.

Research Products from Petroleum

Benjamin Silliman, Jr., the eminent chemist who conducted the first scientific investigation of crude petroleum, in 1855, wrote that it was a raw material from which might be manufactured very valuable products. With an industrial history covering a period of less than seventy years, crude petroleum now is recognized as a resource of the highest economic value to society, because it is essential to agriculture, manufacturing, commerce and the pleasures of life. It is the source of gasoline, which is responsible for the development of the internal-combustion engine, the increase in the use of which has strengthened the entire aspect of modern civilization; it gives the world its supply of illuminating oils, which, by bringing a cheap light to millions of people, have constituted America's greatest gift to the uncultured peoples of the globe; and it provides the lubricating oils upon which the complex mechanical equipment of today is dependent for its operation. Then, too, part of the industrial activity of our country rests upon another petroleum product, fuel oil, which also is required for oil-burning ships. The fact that crude petroleum forms the basis for a chemical products industry of almost unlimited possibilities of development, and as distinctive as the coal-tar industry of the present, brings out, in addition, its predominant importance among mineral raw materials.

The most important product obtained from petroleum is gasoline, whose yield American chemists have greatly increased by the development of "cracking" or pyrolytic processes. These methods consist in breaking up, by temperature and pressure, the more complex into the simpler hydrocarbons. Chemical research has also shown how to extract gasoline from natural gas.

Chemistry and Cottonseed, Sugar and Corn Products Industries

In the cottonseed oil industry chemistry began to take the refinery operations in hand about forty years ago, and the chemist has gradually placed the commercial practice on a scientifically sound foundation. He has improved refining methods, evolved food products, and devised the process of hydrogenating (hardening) the oil to make wholesome edible fats (such as "Crisco"). It has been estimated that chemistry has thus added over \$10 to the value of the crop for every bale of cotton grown. Cottonseed and its by-products are

now contributing \$500,000,000 annually to the national welfare through the aid of the oil miller and refiner and the chemist.

Cottonseed linters, the short fibers covering the hull of the kernel, are now being used for making batting, wadding, stuffing material for pads, cushions, comforts, horse collars, mattresses and upholstery, absorbent cotton, mixing with shoddy, mixing with wool in hatmaking, mixing with lambs' wool for fleece-lined underwear, felt, low-grade yarns, lamp and candle wicks, twine, rope, carpets, cellulose, artificial sausage casings, writing paper, cellulose acetate, viscose, lacquers, smokeless powder, pyroxylin, artificial leather, water-proofing, collodion, artificial silk, and photographic films.

Someone has said, "the sugar industry without the chemist is unthinkable." This statement is indeed correct, for chemistry has been the main factor in the development of sugar technology. Agriculture, manufacture, refining and uses have depended upon chemistry in this important industry; and the many processes the chemist has worked out have brought better, cheaper sugars and growth to all branches of the sugar producing and consuming manufactures.

The manufacture of glucose and grape sugar, or the corn products industry, was built upon a notable discovery of a chemist, namely, the conversion of starch into reducing sugars. Since then—over a century ago—chemistry and chemists have been inseparably and intimately connected with this great industry. Chemical research has shown how to make profitably corn syrup, starches, dextrins, many gums (for adhesive purposes), various sugars, gluten feed, oil, oil cake, and other products from corn. The chemist, in fact, has found the way to manufacture over one hundred useful commercial products from this raw material, the fruit of a majestic, wondrous plant.

Chemical Research on Paper and Leather

The manufacture of pulp and paper is an industry based largely on chemical reactions and processes. It has therefore depended upon chemistry for its technical maintenance and progress. The development of modern papermaking and the enormous extensions of the use of paper in the last quarter-century have been due to the introduction of the three chemical processes, all invented by chemists, by which wood fiber has been made available as a general substitute for rags. Reference is had to the sulfite, soda, and sulfate processes,

which have made the paper industry among the largest in the country.

The chemist has provided all the modern methods of mineral tanning for the leather industry; and as for vegetable tanned leather, he has standardized the quality of incoming material and of outgoing product. That the industry is fully cognizant of the utility of chemistry is evidenced by the great increase in the number of tannery chemists during the past forty years as well as by the national research laboratory that is sustained in Cincinnati by a large group of leather industrialists.

Chemistry in Textile Technology

Chemistry has been similarly beneficial in the extensive textile industry, to which chemical research has given bleaching, dyestuffs, mercerization, rayon (man-made silk), and many other innovations. In modern textile technology the rational methods of the chemist have replaced the uncertain empiricism of the past.

It took about twenty years of scientific research to produce indigo, and thousands of other dyes and related substances have been discovered during the past sixty years through diligent investigation by chemists. Many of these products are indispensable to the health and happiness of man. They constitute a chemical rainbow that makes a pleasing background in the industrial research picture of the present, showing the colorful romance of science and technology.

Prior to the World War the United States was largely dependent upon foreign sources for its supply of dyes. In 1927 dyes of domestic production supplied 94 per cent. of our consumption, and there was, in addition, an exportable surplus of the bulk low-cost colors amounting to over 26,000,000 pounds. The 1927 production of approximately 95,000,000 pounds was an increase of 8 per cent. over the production of 1926. The sales of dyes in 1927 were about 98,200,000 pounds, valued at \$38,200,000.

Rayon, born of chemistry, is now an important factor in the textile field. Many manufacturers are now making all-rayon fabrics, while others are combining rayon with cotton, silk or wool. About one-fifth of the hosiery produced today contains rayon; millions of yards of cloth are being made annually, either wholly or in part of rayon. Approximately \$100,000,000 is invested in the South's rayon industry.

In 1913 the world output of rayon was about 24,000,000 pounds. In 1924 the total was 142,000,000 pounds, and in 1927 it amounted to 250,000,000 pounds. The 1927 production was made up approximately as follows: United States, 75,000,000 pounds; Italy, 39,000,000 pounds; Germany, 30,000,000 pounds; Great Britain, 28,000,000 pounds; France, 20,000,000 pounds; Belgium, 16,500,000 pounds; Holland, 14,500,000 pounds; all others, 27,000,000 pounds.

TABLE III.—RESEARCH IN VARIOUS INDUSTRIES

Fields	Number of Laboratories Studying Problems
Adhesives	50
Automotive vehicles	72
Building materials	52
Ceramics	86
Chemicals, fine	54
Chemicals, heavy	56
Dyes	53
Electrical equipment	60
Electrochemistry	100
Fats, fatty oils and soaps	81
Foods and beverages	142
Fuels and their utilization	148
Metallurgy	249
Paints and varnishes	107
Petroleum products	90
Plastics	53
Pulp and paper	87
Rubber goods	53
Textiles	56
Water, sewage and sanitation	71

Industrial Research in Progress

During the past spring we carried out at Mellon Institute an inquiry as to the types of problems, or technologic subjects, that were under investigation in the industrial research laboratories sustained by manufacturing companies, associations of manufacturers, consultants, and educational institutions in the United States. Many interesting data came to us in consequence. We found, for example, that there are approximately 1000 such laboratories in this country, all of which are especially equipped for investigating problems in specific

industries. The fields covered are also numerous, broad and important, as shown in the following list of the ones having fifty or more research laboratories engaged on their problems (see Table III). This compilation embraces laboratories that are devoting the entire attention of their research staffs to the fields indicated as well as establishments whose work is more varied. While it is quite general in character, it makes clear that there is recognized need for and generous support of industrial research.

The 1000 industrial research laboratories of the United States employ over 16,000 scientists, mainly chemists, and cost about \$110,000,000 a year to operate, everything included. Nearly as much money is being spent annually in transforming the laboratory results into plant practice (sub-commercial development).

Concluding Observations

Industrial research and management constitute the means for effecting technologic telesis, *i. e.*, progress in manufacturing through conscious planning and by the application of intelligently directed effort. The highest aim of industrial research is to deduce the principles of technology and to apply them to the future as well as to the present. Thus by cultivating the field of industrial research we are gradually evolving a system of technologic laws, a definite technonomy, in addition to meeting immediate industrial requirements by solving urgent manufacturing and economic problems. The study of industries in their historic development, location, distribution, and strictly commercial aspects is a subject of constantly increasing usefulness in technology and hence in industrial research.

Technonomy has been referred to as the chief or ultimate aim of industrial research. The highest good of such research in an existing technic field is perfection of process, practice and product, through experiment, invention, and development; and in a new field, the working-out of manufacturing procedure and the discovery of uses for the products, thereby giving rise to a novel industry. The successful direction of research activity towards the achievement of such an important end as a new branch of manufacture that fills a real need is the most valuable contribution that can come from any one industrial research group or laboratory.

MILLILITRE OR CUBIC CENTIMETRE?*

By W. H. Linnell, Ph. D., M. Sc., A. I. C., Ph. C.

THE 1898 EDITION of the British Pharmacopœia used the term "cubic centimetre" in the text, and defined, in the appendix (p. 438), 1 C.c. as being equal to 0.99984 millilitre, and the millilitre as the volume occupied at 4° C. by 1 Gm. of water. In the 1914 edition the use of the term "C.c." was discontinued, and the "mil." became the unit of volume.

It is an interesting study to inquire into the derivation of the two units "cubic centimetre" and "millilitre," which do not possess exactly the same significance. The unit of volume was, in the first instance, based upon the corresponding units of length, 1 cubic centimetre being the volume of a cube each of whose sides was 1 centimetre in length. Unfortunately, to obtain accurately the capacity of a hollow vessel by the measurement of its internal dimensions would be a matter of great difficulty, yet such vessels are essential for the measurement of volumes of liquids. Hence units of volume came into being which were defined as the space occupied by a specified weight of water. At this period, therefore, two definite units of volume were in use (a) those based directly upon units of length, and (b) those defined in terms of a specified weight of water.

The founders of the metric system endeavoured to secure a simple numerical relationship between the two units of volume by defining the unit of mass as the mass of a quantity of water which at its temperature of maximum density occupied 1 cubic decimetre, and hence the litre became the space occupied by 1 kilogramme of water under the conditions specified.

Another difficulty then arose: a quantity of water is unsuitable for use as a standard weight. The Commission des Poids et Mesures, at the end of the eighteenth century, therefore entrusted Lefèvre-Gineau and Fabbroni with the construction of the standard kilogramme, which was afterwards known as the "Kilogramme des Archives."

Some conception of the magnitude of the task may be obtained when one considers that an error of 1/1000 millimetre in the sides

*Reprinted from the *Pharmaceutical Journal*.

of a 10 centimetre cube would cause an error of 30 milligrammes in the weight of the kilogramme, and a divergence of 0.1° C. from 4° C. for the temperature of the water used would be responsible for an error of 15 milligrammes in the standard. The work was achieved, and it has since been established that the actual error made was under 30 milligrammes, which, when one consdiers that the standard was made more than 128 years ago, represented a very high degree of accuracy.

In 1871 the Commission Internationale du Mètre decided that "the International Kilogramme shall be deduced from the Kilogramme des Archives in its actual state." Therefore, the kilogramme is the mass of a particular standard weight, and is not the mass of a quantity of water which at its temperature of maximum density occupies 1 cubic decimetre.

In 1901 the Comité International des Poids et Mesures resolved that "the unit of volume for determinations of high precision is the volume occupied by a mass of 1 kilogramme (i. e., the Kilogramme des Archives) of pure water at its maximum density, and under normal atmospheric pressure, this volume being termed the 'litre.'" Hence there is a difference between the cubic decimetre of water and a litre of water occasioned by the error in the standard kilogramme. This difference has been determined very accurately at the Bureau Internationale des Poids et Mesurs at Sèvres.

1910.—Guillaume : 1 litre = 1000.029 C.c.

Chappuis; 1 litre = 1000.026 C.c.

De Lepinay, Buisson, and Benoit; 1 litre = 1000.027 C.c.

It has been recently shown that the best value to take is 1 litre = 1000.028 C.c.

Most students are told that 1 C.c. of water weighs 1 Gm., and that 1 C.c. is the volume of 1 Gm. of water—statements which are incorrect. Again, although the above differences are negligible for practical purposes, graduated glass ware is usually graduated and standardised at 15° C., and under these conditions a flask which contains a quantity of water which has an apparent weight in air of 1000 Gms. has a capacity of approximately 1002 C.c. The error

here is equivalent to ten times the allowable error in a Class A (N. P. L.) graduated vessel.

The millilitre, which is one-thousand part of the standard volume, should therefore not be confused with the cubic centimetre, and although the difference between C.c. and mil. is negligible for general purposes, the use of the "mil." should be encouraged, because it will tend to concentrate attention on the true meaning of the terms.

MEDICAL AND PHARMACEUTICAL NOTES

GINSENG CULTURE OFFERS OPPORTUNITY TO PATIENT CULTIVATOR—Prospective growers of ginseng are reminded by the United States Department of Agriculture that "plunging in ginseng" is likely to prove disastrous. Sane cultivation of this root crop, however, offers "attractive possibilities to patient cultivators who appreciate its limitations," the department says.

Market possibilities and approved methods of growing ginseng are described in a recent revision of Farmers' Bulletin 1184-F, "Ginseng Culture," by Dr. W. W. Stockberger, principal physiologist in charge of the Office of Drug, Poisonous, and Oil Plants.

The ginseng industry, says Doctor Stockberger, still suffers from the disrepute into which it was brought through exaggerated claims by dealers. The future success of the cultivated ginseng in North America will be determined to a great extent by the attitude of the growers, he says.

Ginseng has long been valued by the Chinese for medicinal use and it is on this oriental market that American growers must depend, says the bulletin, as the plant has little value here or in other countries outside of China. It is consumed in negligible quantities even by the Chinese in this country.

Although exports of ginseng are now considerably smaller than in some previous years, the prices paid for the root at present are relatively high, says the author, and a continuance of the demand for American ginseng may reasonably be expected. The annual ex-

ports for the past ten years have averaged more than \$2,000,000 in value, and prices during the same period have ranged from \$1 to \$13 a pound for the cultivated roots, with a somewhat higher price for the wild ginseng. Well-managed plantings are estimated to yield about a ton to the acre on the average, although much larger yields are frequently reported.

There is always a ready sale for the cultivated roots which closely resemble the wild in quality and condition, and prudent growers will not fail to adopt the wild root as the standard of future production, says Doctor Stockberger. Elimination of the poorer grades of cultivated American ginseng now found on the markets, he says, would tend to insure more uniform prices for the root and lessen the danger of depressing the market.

A copy of the bulletin may be obtained by writing to the United States Department of Agriculture, Washington, D. C.

RESEARCH IN PLANT INDUSTRIES COVERS WIDE RANGE OF INTEREST:—Continued progress in the investigation and improvement of plant production and allied industries is reflected in the annual report of the Bureau of Plant Industry of the United States Department of Agriculture which was made public today. The report submitted to the Secretary of Agriculture by Dr. W. A. Taylor, chief of the bureau, describes some of the most noteworthy achievements of the bureau during the last fiscal year. These have to do with fruits, fruit trees, grain, grasses, cotton, tobacco, vegetables, and forage; and drug, fiber, and other plants.

Disease, one of the limiting factors in economical plant production, is being successfully combated in many instances through the use of varieties that are resistant or immune from the specific diseases in question. Resistant varieties are obtained sometimes through introduction from foreign countries, sometimes by selection, and more often by selection and breeding. Doctor Taylor reports progress in the development of wheat varieties resistant to rust, scab, and bunt diseases; oat varieties resistant to stem rust; corn resistant to root rot; tomatoes resistant to wilt and blight; strains of lettuce resistant to brown blight; and cucumbers resistant to mosaic.

Increased attention has been given the soy bean on account of the possibilities of the crop for oil and oil meal. About 1500 new introductions were received during the year from Manchuria and

other foreign countries. From these new varieties it is hoped to develop some that are of high oil content for use by oil mills, and others of low oil content to aid hog-feeding interests in the solution of the soft-pork problem.

The benefits of growing only one variety of cotton in a community, as advocated by the bureau, are gradually being recognized. Through this method it is possible to change the basis of production from the usual condition of mixed and mongrelized seed stocks to regular supplies of pure seed, so that all of the farmers of an organized community or district can produce fiber of the same character. One-variety communities are the best means of improving the entire output of cotton, and consequently higher prices can be expected because of the uniformity of the crop throughout the community.

The possibility of producing rubber in the United States is now receiving attention. The guayule plant, which grows wild in northern Mexico and to a limited extent in western Texas, could be cultivated and grown in large quantities if remunerative prices were assured. Processes for extracting and refining guayule rubber have been applied extensively to the natural product in Mexico. Other species of native plants have been found to contain rubber and are being studied in the bureau to determine their cultural characters and requirements.

The promising new paper-mulch method of stimulating certain crops and incidentally controlling weeds has been investigated by the bureau during the year. It consists of the use of impervious black paper as a mulch. Tests during the last four years have demonstrated conclusively that various garden crops grown in the eastern United States are stimulated to greater growth by the paper mulch, and weeds are reduced to a minimum. A wide use of the paper mulch idea, however, appears to depend upon the development of paper that is inexpensive enough to permit its use at a profit.

Numerous other topics of interest to a wide range of plant industries are discussed in the report. They include results of investigation and study on such subjects as perfumery plants, oil and drug plants, tobacco, sugar plants, nuts, bulbs and flowers, abaca, fiber flax, and hemp. A list of several hundred publications issued by bureau specialists is included in the report and serves to give a more comprehensive idea of the scope of the bureau's researches during the year.

LIVER EXTRACT, FRACTION A5—Scientists have for some time known that liver, when taken as food, produces an effect upon certain vital processes of the body. This knowledge led Minot and Murphy, of Harvard University, to experiment on liver feeding in cases of uncomplicated pernicious anemia, and they reported its beneficial effect in bringing about blood regeneration.

Efforts have been made to isolate from liver the stimulant to blood regeneration in a form that might be administered as a medicine. Cohn and his co-workers at Harvard University, in July, 1927, reported the discovery, by chemical fractioning of the liver, of an alcohol-precipitable fraction containing the "active material effective in pernicious anemia."

These results have been verified by Dr. W. Herschel Knap, of the Medical Research Foundation at Frankford, Philadelphia, and the fraction which Doctor Knap has found to produce the same results as raw liver in pernicious anemia (Addison's anemia) is designated as LIVER EXTRACT, FRACTION A5. This fraction is free of proteins, carbohydrates and lipoids.

LIVER EXTRACT, FRACTION A5 for pernicious anemia is supplied in hermetically-sealed vials and in capsule form. For further information, address its manufacturer, H. K. Mulford Company, Philadelphia, Pa.

BOOK REVIEWS

ANNUAL REPORT, ESSENTIAL OILS, SYNTHETIC PERFUMES, ETC.
1927. Published by Schimmel & Co., Miltitz, near Leipzig. 250 pages with color plates.

This comprehensive little volume comes to the reviewer's desk each year and its uniqueness and completeness always earns for it a secure place in the consulting library of the College. Last year when some controversy transpired with respect to Australian Sandalwood oil it was not strange that Schimmel's Report carried between its covers more specific information about that oil than could be found anywhere else.

One judges the up-to-dateness of a work like this by noting the recency of its bibliographic references and it is worthy of note that the

great majority of such references here are of very recent date. It is obvious that the work of translating the original German has not been that of an American for the oddities of expression and of spelling, oddities insofar as they are American viewed, are tintured with Teutonic English. Not that this detracts from the value of the book at all—but such expressions as “Novelties”—when new discoveries are meant—and “odours”—“oxydation,” etc., strike quaintly on American readers.

For thoroughness of records, however, and the up-to-dateness of the subject-matter the report meets its usual high standard.

It is a work of reference that should be available each year, to all who are connected with the volatile oil and perfume industry.

The reviewer does not know how this book can be secured. Fritzsche Brothers, 82 Beekman Street, N. Y., are the American agents for Schimmel & Co.

INDEX TO VOLUME 100 OF THE AMERICAN JOURNAL OF PHARMACY

AUTHORS

	PAGE		PAGE
Arny, H. V.—		Pharmacist in Relation to the	
Progress of the Research Con-		Public Health	561
ference	530	Dales, H. H.—	
Bayles, J. C.—		Some Reactions of Pharmacol-	
The Old Oaken Bucket—Re-		ogy on Pharmacy	299
vised by a Sanitarian	657	Eberle, E. G.—	
Bennett, R. R.—		Historian's Report, American	
Pharmacy as a Career	697	Pharmaceutical Association,	
Bugee, E. P.—		1928	589
Bio-Assay of Preparations of		England, Joseph W.—	
Ovarian Follicular Hormone	595	Wellcome Historical Medical	
Bunn, H. L.—		Museum and Its Founder—	
Relative Sensitivity of Cats to		Henry S. Wellcome	745
Various Mydriatics and My-		Foote, P. A.—	
otics	596	Action of Nitrosyl Chloride on	
Burt, Joseph B.—		2, 2, 4-Trimethyl Pentane ...	599
What is a Ten Per Cent. Solu-		Action of Nitrosyl Chloride on	
tion?	636	Penta-Decane	600
Cameron, John—		Freeman, Lewis G.—	
Progress of Pharmacy in China	162	Digitalis Preparation for Intra-	
Chen, K. K.—		venous Injection	463
Racial Difference of the Mydri-		Galdston, Iago—	
atic Action of Ephedrine, Co-		Debunking Health Education ..	703
caine and Euphthalmine	595	Garner, W. B.—	
Clark, A. H.—		Reliability of Preparations of	
The Alkaloids of Ceanothus		Ergot and Necessity for	
Americanus. II. Extraction		Standardization	318
of the Alkaloid	240	Gershenfeld, Louis—	
Cock, E. Fullerton—		The Preservation of Food	201
European Flowers in Commerce		Germuth, Frederick G.—	
and Culture	487	Mercuric Ammonium Chloride	
The Pharmacist's Responsibil-		—Facts Concerning Its For-	
ity in Community Health ...	173	mation and Properties	285
Cummings, Hugh S.—		Gordon, Samuel M.—	
The Pharmacist and the Public		Phytochemical Notes—No. 98.	
Health	171	The Seeds of Nepeta Cataria	155

PAGE	PAGE
Phytochemical Notes—No. 99. The Aldehydes of <i>Pinus Jerfreyi</i> 156	Horn, David Wilbur— Eutectic 558
Studies in the Genus <i>Mentha</i> . 16. Non-Volatile Constituents of <i>Mentha Aquatica</i> , Linne, 433, 509	Kremers, Edward— Action of Nitrosyl Chloride on Penta-Decane 600 Action of Nitrosyl Chloride on 2, 2, 4-Trimethyl Pentane ... 599 Apothecary in Literature—No. 32—A Charlatan of the Iowa Frontier 294 Chemistry of the Agrumens with Special Reference to that of Sweet Orange Peel 599
Griffith, Ivor— Editorials: Crystal and Colloid 611 George M. Beringer—A Tribute 427 In Memoriam—Edgar Fahs Smith 279 New Home of the Journal .. 661 Old Books Again 125 Popular Fallacies 59 The "Good" Old Days 1 "Unprepared and Uninspired" 485 The Realm of the x-Ray 9	LaWall, Charles H.— Editorial: "Aberglaube und Hexerei" .. 715 Browsings in Books, Both Old and New 4 Browsings in Old Books, II ... 100 Browsings in Old Books, III.. 283 Olive Oil and Its Substitutes .. 616 The Romance of Cookery 128
Greenbaum, Frederick R.— New Iodo Derivatives of Phtha- leins 374 New Organic Salts of Telluric Acid 630 Organic Addition Compounds of Calcium Chloride and Cal- cium Iodide 600 The Calcium Salt of Para-Iodo- guaiacol and Para-Iodoguaia- colcarbonate 112	Leffmann, Henry— Editorials: Corrosive Materials for the Household 547 Hard Sledding for the Metric System 281 The Ultraviolet Craze 61 Commencements and Degrees 357 Poison Rum Again 197 Sodium Alum 474 Sucrose vs. Glucose 246
Harvey, Ellery H.— Essential Oils as Antiferments 524	Leonard, George F.— Comparative Results from the Testing of Various Germi- cidal Agents 103
Heacock, Edna— Comparative Results from the Testing of Various Germi- cidal Agents 103	Linnell, W. H.— Millilitre or Cubic Centimetre.. 792
Hepburn, Joseph Samuel— Biochemical Studies of the North American <i>Sarraceniacæ</i> . The Use of the Genus <i>Sarracenia</i> in Medicine: A Review 675	Lloyd, J. T.— An Accurate Method for Ob- serving the Meniscus of Liq- uids Confined in Small Tubes 601

	PAGE		PAGE
Sponge, Its History in Medicine With a Brief Account of Its Habits and Structure	232	Rosenthaler, L.— Applied Phyto-Microchemistry	92
McAdie, Alexander— How Big is an Acre?	400	Chemical Characterization of Drugs	454
Matlack, M. B.— Chemistry of the Agrumens with Special Reference to that of Sweet Orange Peel..	599	Microchemical Characterization of Drugs	757
Some Preliminary Observa- tions on the Coloring Matter of Citrus Juices	243	Simond, A. E.— Bio-Assay of Preparations of Ovarian Follicular Hormone	595
Mayhew, Edward— Pharmacy in Relation to Science	333	Strock, Lester W.— Sodium Alum	474
Merrill, E. C.— Preliminary Studies of the Rosenheim-Drummond Color Tests of Vitamin A in Cod Liver Oil	601	Stroup, Freeman P.— The Rare Elements	499
Minehart, John R.— Promiscuous Sale of Hypnotics	261	Stuhr, Ernest T.— Medicinal Trees of the United States	598
Munch, J. C.— Mydriatic Potency of Ephedrine and Its Salts	597	Swallow, Edward— Australian Sandalwood Oil Compared with the Official East Indian Oil	598
Relative Sensitivity of Cats to Various Mydriatics and My- otics	596	Terry, Ralph E.— Notes on Spirits of the National Formulary V	625
Toxicity of Thallium Sulphate	596	Towle, E. C.— Preliminary Studies of the Rosenheim-Drummond Color Tests of Vitamin A in Cod Liver Oil	601
Nitardy, F. W.— Pharmaceutical Manufacturing	365	Viehoever, Arno— The Heart	718
Peacock, Bertha L. DeG.— Further Study of the Tannin of Geranium Maculatum	548	Weidlein, Edward R.— Industrial Changes Due to Chemistry	765
Peacock, Josiah C.— Further Study of the Tannin of Geranium Maculatum	548	Wilson, G. Fox— Nicotine as an Insecticide	403
Report on Availability of Cer- tain New Biologicals	598	Wood, Horatio G.— Sumac and Poison Ivy	663
Pittenger, Paul S.— Biologic Assays for Vitamines	63	Youngken, Heber W.— Chairman's Address, Plant Science Seminar, 1928	572

SUBJECTS

	PAGE		PAGE
"Aberglaube und Hexerei"—Editorial	716	Blood Sugar	481
Acid, Nitric, by New Process	351	Bohr's Theory	185
Acid, Tannic, in Burns	121	Book, Oldest Medical	271
Acid, Telluric, New Organic Salts of	630	Books, Brownings in Old and New	4, 100, 283
Acre, How Big?	400	Books, Old Again	125
Advertising, Health Angle in	2	Borax, New Source	480
Agrumens, Chemistry of	599	Burns, Treatment with Tannic Acid	121
Air Pollution by Automobiles	419	Cages for Vitamin Assays	67
Alcohol and the Heart	736	Calcium Chloride and Iodide, Organic Compounds	600
Alcohol, Solid	650	Calcium Salt of Para-Iodoguaiaicol and Para-Iodoguaiaicol-carbonate	112
Alkaloids of Ceanothus Americanus, II	240	Cancer and Alkalinity	606
Alkaloids, Racial Differences to Reaction of	595	Cancer Cells	483
Allonal	693	Candy	409
Alum, Controversy	605	Carbon-Monoxide Hazard	649
Alum, Sodium	474	Cat-eye Assay Method	596
American Journal of Pharmacy, New Home of	661	Caustic Poison Act	46
Amytal	693	Centennial Reminiscence	187
Anemia and Iron	410	Chemical Discoveries, Pharmacists and	333
Anemia, Copper in	347	Chemical Industries, Early American	775
Angstrom Unit	22	Chemical Preservatives	229
Antiseptic Defined	602	Chemistry and Industrial Changes	765
Apothecary in Literature	294	Chemistry and Refrigeration	771
Appetite Loss	119	Chemistry in Industry—1820 to 1860	772
Aquaticol	519	China, Pharmacy in	162
Assays, Biologic, for Vitamines	63	Chlorine in Water, Bacterial Action of	48
Assays, Digitalis	742	Citrus Juices, Coloring Matter of	243
Atom, Inner Structure of	176	Cinchona Alkaloids, Moth-proofing with	117
Automobiles and Air Pollution	419	Cocoonut Oil, Fatty Acids of	266
Avocado, Oil	652	Cod Liver Oil in Anemia	541
Banisterine	541	Cod Lived Oil Preparations, Misbranded	47
Barbital	693	Coffee, Beneficial	52
Barbital Addiction	199	Colds and Diet	651
Baumé Formula	709	Commencements and Degrees	357
Beringer, George M., In Memoriam—Editorial	427		
Beringer, George M., Portrait	428		
Beverage Standards	709		
Bites and Stings	534		

	PAGE		PAGE
Cookery, Romance of	128	Ergot Preparations, Stability of	318
Coolidge Tube	27	Erysipelas Control	188
Copper in Anemia	347	Ether Preservation	650
Corrosive Materials for the Household—Editorial	547	Ethylendichloride Fumigant	44
Crystal and Colloid—Editorial ..	611	Eutectic	558
Cubic Centimetre or Millilitre? ..	792		
		Fallacies, Popular	59
Dandruff Treatment	118	Feasts, Roman	135
Daphnia Assays	742	First Aid Methods	449
Declaration of Ingredients and Contents	415	Flavor, Maple	711
Degrees and Commencements ...	357	Flies, Transmission of Disease ..	385
Dehydrated Foods	214	Flowers, European in Commerce and Culture	487
Diabetic Manual, Book Review ..	660	Food, Ancient	135
Dial	693	Food, Canned	218
Diet and Colds	651	Food, Metals in	268
Digisol	463	Food Preservation	201
Digitalis, Active Substances of ...	740	Foods, Dehydrated	214
Digitalis Preparation for Intra- venous Injection	463	Fumigant	44
Disease, Transmission by Flies ..	385		
Disinfectant, Pine Oil	479	Garden of Herbs	123
Drug Market Report, P. P. A., 1928	575	Germicides, Testing of	103
Drug Store Experience	486	Ginseng Culture	794
Drug Store Ownership Bill Un- constitutional	685	Glass, Pollopas	115
Drugs, Chemical Characterization of	454	Glass, Resistant	45
Drugs of India—Book Review ..	659	Glucinum	503
Drugs, Microchemical Tests	757	Glucose vs. Sucrose	246
		Glycerine from Whale Oil	418
Edgar Fahs Smith—In Memoriam	279	"Good" Old Days—Editorial	2
Education, Health	703	Grape Fruit, Medicinal Value of ..	121
Electrons	179		
Elements, Rare	499	Hay Fever and Pollen	419
Emulsions, Paraffin Assay	482	Haydock, Susannah Garrigues, Deceased	655
Emulsions, Theory of, Review ..	276	Health Education	703
Encyclopedia, Chemicals, Kingzett —Book Review	424	Heart Hormones	727
Ephedrine Potency in Mydri- asis	595, 597	Heart Rules	736
Ephedrine, Standardization of ...	350	Heart, The	718
Ephetonine	271	Herbs, Garden of	123
Ergosterol, Irradiated	344	Hypnotics, New	692
		Hypnotics, Promiscuous Sale of ..	261
		Incunabula	100
		India Drugs—Book Review	659
		Insect, Definition of	408
		Insecticide, Nicotine as	403

PAGE	PAGE
Insecticides Less Dangerous Than	Mercuric Ammonium Chloride .. 285
Arsenic 46	Mercury Ointment, Colloidal 118
Insects and Public Health, Cata-	Metallic Poisoning 117
log of 421	Metals in Our Food 268
Insects, Key Catalog—Book Re-	Methane, Synthesis from Water
view 545	Gas 116
Iodine Ointment, Stainless 268	Methanol, French Test for 352
Ipral 693	Metric System, Hard Sledding
Iron and Anemia 410	for 281
Iron. and Nutrition 345	Microchemistry, Phyto, Applied 92
Iron and Steel, Early History of 44	Milk, Human, Composition of ... 188
Isotopes 183	Milk, Malted, Bootleg 604
Ivy, Poison and Sumac 663	Millilitre or Cubic Centimetre? .. 792
Ivy Poison, Treatment 416	Mosquitoes 389
Krusen, Dr. Wilmer, New Presi-	Moth-proofing with Cinchona Al-
dent of P. C. P. & S. 53	kaloids 117
Labeling 654	Museum, Wellcome Medical 745
Laboratory, Portrait of Group,	National Formulary V, Spirits of 625
Old Army 654	Neonal 693
LaWall, Charles Herbert, Rem-	Nepeta Cataria, Seeds of 155
ington Honor Medalist, 1928,	Neptal 272
with Portrait 359	Newton and Light 15
Leprosy Drug 188	Newton's Book Plate 7
Life, Mystery of 642	Nicotine as Insecticide 403
Light, Green-violet Effect on	Nitric Acid by New Process 351
Plants 350	Nitrogen Fixation—Book Review 484
Liver Extract Fraction A-5 797	Nitrosyl Chloride, Action of, on
Liveries and Sotelties 140	Certain Organic Compounds
Lloyd Library and Its Makers ... 426	599, 600
Lloyd Library Bulletin 426	Noctal 693
Luminal 693	Oil, Avocado 652
Malta Fever, New Serum for ... 353	Oil, Cocanut, Fatty Acids of ... 266
Maple Flavor 711	Oil, Cod Liver, in Anemia 541
Materia Medica, Culbreth—Book	Oil, Cod Liver, Preparations, Mis-
Review 57	branded 47
Matter, Electricity Energy—Book	Oil, Cod Liver, Vitamins in 120
Review 355	Oil Content of Seed 417
Medical, Oldest Book 271	Oil of Santal, Australian 598
Meniscus Studies 601	Oil, Olive, and Its Substitutes ... 616
Mentha Aquatica 433, 509	Oil, Whale, Glycerine from 418
Mentha, Studies in the Genus 433, 509	Oils, Essential, Schimmel Annual
Mentha, Symposium on the Genus 647	Report—Book Review 797
Menthol, Synthetic 55	Oils, Volatile, as Anti-ferments.. 524
	Oils, Volatile, Extraction of 269

PAGE	PAGE
Ointment, Iodine, Stainless 268	Pills, Vaccination 50
Ointment, Mercury, Colloidal ... 118	Pine Disinfectant 479
Old Oaken Bucket—Revised 657	Pinus Jeffreyi, Aldehydes of 156
Olive Oil and Its Substitutes 616	Pituitary Principles 479
Organic Analysis, Allen's—Book Review 195	Planck's Constant 186
Ovarian Hormone, Bioassay 505	Plant Folk Lore, Hermann Peters Book Review (German) 192
Paraffin Emulsions, Assay 482	Plant Industries, Research in 795
Para-iodoguaiacol 112	Plant Science Seminar, Chairman's Address 572
Peanut Butter, Composition of ... 269	Plant Science Seminar, Sixth An- nual Report 569
Phanodorm 693	Poison Ivy Treatment 416
Pharmaceutical and Medical His- tory—Book Review (German) 658	Poison Rum Again 197
Pharmaceutical Manufacturing .. 365	Poisoning, Metallic 117
Pharmacist and Public Health ... 171	Poisons, Detection of, Auten- rieth Review 191
Pharmacist in Relation to Public Health 561	Pollen and Hay Fever 419
Pharmacists and Chemical Dis- coveries 333	Pollopas, A New Glass 115
Pharmacists in Government Serv- ice 297	Preservation of Food 201
Pharmacology and Pharmacy ... 299	Preservatives, Chemical 229
Pharmacopœia Londinensis 284	Prohibition and Public Health ... 264
Pharmacy and Community Health 173	Propenal 693
Pharmacy as a Career 697	Protons 181
Pharmacy in China 162	Quercetanus 6
Pharmacy in Relation to Science.. 333	Radium 507
Pharmacy, Future of 315	Radon 502
Pharmacy Week—Editorials. 614, 615	Rare Elements 499
Philadelphia College of Pharmacy and Science:	Rays, Infra Red 21
Dedication of New Building .. 248	Rays, Ultra-violet 20
Dr. Wilmer Krusen New Pres- ident 53	Rays, Ultra-violet, Craze 61
One-hundred and Sixth An- nual Commencement 393	Report of Historian A. Ph. A. ... 589
Report of 107th Annual Meet- ing 256	Research in Plant Industries 795
Phthalein, New Iodo Derivatives of 374	Research Progress 530
Phytochemical Notes, No. 98:	Romance of Cookery 128
Seeds of Nepeta Cataria 155	Röntgen 23
Phytochemical Notes, No. 99: Al- dehydes of Pinus Jeffreyi 156	Rum, Poison, Again 197
Phyto-Microchemistry Applied .. 92	Salyrgan 273
	Sandoptal 693
	Sarracenia, Genus, in Medicine .. 675
	Schroeder, Johann Christian 8
	Sea Sickness Remedy, Sodium Nitrite 345

	PAGE		PAGE
Sea Sickness, Salt Water Baths in	542	Tobacco, Denicotinized	603
Seed, Oil Content of	417	Tolerances for Medicinal Tablets	273
Seeds, Ancient	48	Tolerances for Tablets	653
Shoemaker, Sr., Clayton French, Deceased	655	Trees, Medicinal of the U. S.	598
Silver Content of Organic Silver Preparations	478	Tuberculosis, Vaccination	49
Smith, Edgar Fahs—In Memoriam	279	Ultra-violet Craze	61
Soda Water Origin	542	Ultra-violet Rays and Plant Cells	483
Sodium Nitrite, Sea Sickness Remedy	345	"Unprepared and Uninspired"— Editorial	485
Soil, Common Elements in	708	Urine Sugar, New Test	608
Solubilities of Compounds—Book Review	713	Vaccination, Tuberculosis	49
Solution, What is a Ten Per Cent.?	636	Vaccination, Typhoid and Cholera with Pills	50
Soneryl	693	Vitamin-A, Color Test	541, 601
Sound Waves, Chemical Effects of	267	Vitamins, Biological Assays for	63
Spectrum	17	Vitamins in Cod Liver Oil	120
Spirits of the N. F. V.	625	Volatile Oils, Extraction of	269
Sponge in Medicine	232	Water, Impure, Illegal in Ger- many	352
Sterilization of Hypodermic Syringes	273	Water Sterilization	708
Stings and Bites	534	Water, Sterilization of, with Chlorine	48
Sucrose vs. Glucose	246	Water, Stream, Surface Purifica- tion	59
Sugar, Urine	608	Weed Killer	481
Sulphate Ion, Volumetric Deter- mination	350	Wellcome, Henry S.—Portrait and Sketch	754
Sulphocyanates in Medicine	707	Wellcome Medical Museum	745
Sumac and Poison Ivy	663	White-wash, High Temperature	266
Sunlight	605	Wöhler and Urea—Editorial	431
Symbols, New	708	x-Ray Dangers	36
Syringes, Hypodermic, Steriliza- tion of	273	x-Ray in Industry	34
Systems, English and Metric	400	x-Rays in Nature	19
Tablets, Tolerance for Medicinal	273	x-Ray Inventions	25
Tablets, Tolerances for	653	x-Ray, Realm of the	9
Tannin of Geranium Maculatum	548	x-Rays and Evolution	41
Telluric Acid, New Organic Salts of	630	Yeast, An Ancient Remedy	651
Thallium Toxicity	596		



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